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QUARTERLY

OF THE

National Fire Protection Association

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National Fire Protection Association.

Executive Office, 87 Milk Street, Boston, Mass.

Franklin H. Wentworth, Secretary

October 1918

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American Institute of Consulting Engineers.
American Institute of Electrical Engineers.
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Vancouver Island Fire Underwriters' Association.
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Western Canada Fire Underwriters' Association.
Western Canada Grain Association.
Western Factory Insurance Association.
Western Insurance Bureau.
Western Sprinklered Risk Association
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Reports on fires appearing in the Quarterly are copies of or extracts from written reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.

Courtesy Messrs. Webster and Stevens, Seattle.

OIL STORAGE ON WATERFRONT AT SEATTLE.

See Page 118.

The Quarterly

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The Gillespie Loading Plant Disaster.

Sixty-four men were reported missing and 325 of of the 700 buildings of the T. A. Gillespie Loading Plant at Morgan, N. J., were destroyed on October 4th and 5th as the result of the latest of the disastrous fires and explosions that have occurred from time to time in munitions factories ever since the commencement of the war. The official statement issued by the President of the Corporation owning the plant indicates the probable cause, and gives some idea of the magnitude of the fire:—

"The T. A. Gillespie Loading Company plant consisted of 700 buildings, of which 325 were destroyed. There were thirteen complete units for the loading of shells; 12 of these units we know to be destroyed. The 13th unit we have not been able to examine thoroughly, but it has been damaged somewhat.

"All the cottages used and occupied by the superintendents and their families, together with the Administration building, mess halls, etc., have been destroyed.

"The labor camp, consisting of 40 buildings, is practically intact. The powerhouse, docks, traffic system through the works and the storage warehouses and magazines have not been damaged to any great extent.

"The first explosion occurred on Friday evening about 7.40 o'clock in the No. 1 unit of the six-inch shell plant. From there it traveled through the No. 2 unit of the six-inch shell plant, and it is our opinion that that plant was destroyed by fire caused by the exploding shells from the No. 1 plant.

"In the No. 1 plant 76 men were working, 12 being United States Government inspectors. Of the 76 men, 12 are accounted for, including two inspectors. The balance, a total of 64, are missing, less than this number of bodies having been recovered.

"After a careful inspection on the site of the plant it is clear that the initial explosion, in all probability, did not occur in either the T.N.T. service magazine or in the low pressure steam jacketed amatol kettles, as previously reported in some of the press dispatches.

"All the available evidence points to the initial explosion having occurred in one of the regular operating rooms in which the 155 millimetre loaded shells are handled under established methods which have been successfully in vogue in this plant, without accident, for over three months. Any more definite information as to the original cause is purely a matter of conjecture, one of the possibilities being an inadvertent act on the part of one of the operators, a risk of this character being unavoidable with an operation of this kind.

"The spread of the fire and the subsequent events which involved the other units and parts of the operating area of the big plant were primarily due to exploding shells and the main storage areas, including the principal magazines located at suitable distance from the operating plant area, were not involved in any way.

"It must be understood that this official report has of necessity been delayed as the incipient fires following the principal explosion introduced a risk which did not justify inspection of the areas until this morning, by which time the explosions had ceased, and with the exception of a few small and isolated fires, which are being extinguished, left the plant in a fairly satisfactory condition as regards the risk of any further fires and explosions."

* * *

Oil Storage at Seattle. The frontispiece to this issue of the QUARTERLY shows the conditions under which soy bean and other Oriental oils are being stored on the waterfront at Seattle. It is reported that a large wooden warehouse for the storage of canned salmon is being built alongside the acres of wooden cases in which the soy bean oil is contained, and that barrels of oil extend solidly to the fence of a steel shipbuilding plant. While it may be argued that the probability of fire originating among the cases of oil is not very large, the possibility of such a fire cannot be disregarded—to say nothing of the hazard of an exposure fire. In the event of a fire from any cause securing a hold in the woodwork on which the cases of oil are stored so that burning oil was permitted to reach and float away upon the water, the probable consequences to the shipping in the harbor and to the other properties on the waterfront are too terrible to bear thinking about. The value of the oil itself is said to be far in excess of $20,000,000, and if this were the only consideration the existing methods of storage would be open to condemnation on the ground that such values should not be exposed to possible destruction by a single fire, for it need hardly be said that the heat that would be generated when once the oil began to burn would place the task of quick extinguishment beyond human power.

* * *

President Stewart and the Insurance Agents. Speaking at the Annual Meeting of the National Association of Insurance Agents (Member N. F. P. A.) at Cleveland on September 19th, President F. J. T. Stewart made a fine appeal to the Local Agents to use their unique opportunities for impressing upon the ordinary property owner the absolute duty of providing proper safeguards against fire. He said:

"Aside from the employees of fire insurance companies and inspection bureaus, there is no other group of men so well qualified as insurance agents, by experience and opportunity, to carry on the daily fight for the conservation of our resources against destruction by fire. Even in times of peace there is an obligation on the part of every insurance agent, both to the policyholder and the insurance company he represents, to inspect each piece of property which he insures and indicate how the fire hazard may be better safeguarded. It is therefore evident that this obligation during the emergencies of war is many times greater. It would seem as if no better opportunity has been afforded any other group of men to materially assist in the conduct of the war and yet do comparatively little more than is ordinarily expected of them Indeed, no successful and progressive agent ordinarily neglects to familiarize himself with the standard regulations for safeguarding against fire. Thus equipped he inspects the property of his customers and advises them regarding precautions which should be taken.

The agent who does not do so now is unpatriotic in addition to being unworthy of the trust reposed in him by his customers and the insurance company which he represents.

"I would therefore urge as a war measure, that a special drive be made in connection with the customary inspections by agents for fire prevention purposes. An appeal to property owners at this time should receive a patriotic response. It is essential that this work should have a prominent place in your daily routine.

"It is no doubt unnecessary to remind you that full information on regulations for safeguarding against fire should preferably be secured from your insurance organization having jurisdiction in the territory concerned. Naturally all your suggestions for improvements should be in harmony with the standards of such organization which I believe ordinarily follow the regulations of the National Fire Protection Association and the National Board of Fire Underwriters, as well as recognizing municipal and State laws.

"I trust you will treat this entire subject with the utmost seriousness and convince the property owner of its importance. Now that our people, once instinctively wasteful, are beginning to take a pride in frugality, there is every reason to feel that if patriotically appealed to and wisely advised regarding fire prevention they will apply themselves to the task and make every day Fire Prevention Day. If they do not do so, the responsibility is largely yours if you have not fully informed them of its importance."

It is good to know that the appeal was not addressed to deaf ears. The cause of fire prevention has no better friend than Fredrick V. Bruns, Chairman of the Fire Prevention Committee of the Agents' Association, and there are indications that the members of the Association as a whole are with him in this direction.

* * *

Smoking in Hospitals.

In a paper on the general subject of hospital fire protection, read before the Dominion Association of Fire Chiefs in August, Chief J. W. Graham of Ottawa (Member N. F. P. A.) drew attention to a point which has not hitherto received much thought, but which is of considerable importance, particularly in institutions where there are convalescent soldiers. The Chief pleads for the provision of proper smoking rooms. As he points out, the large majority of men are addicted to smoking, and there is no time when it is more natural to desire to indulge in the practice than during convalescence. The hazards of surreptitious smoking in hospitals are too obvious to need statement, and Chief Graham expressed his conviction that the recent hospital fire in Ottawa, in which three little children were burned to death, was attributable to that very thing. He believes that a convalescent patient was smoking in a dark corner near an opening to the linen chute, trusting to the draft of air circulating up the chute to carry off the smoke. Becoming alarmed at the approach of an attendant, the smoker threw his lighted cigar or cigarette down the shaft, where it fell upon combustible material and started the fire.

Ontario Fire Prevention Convention and League.

Following closely upon the publication of the report on the fire waste in Canada prepared for the Commission of Conservation by Mr. J. Grove Smith, the first Canadian Fire Prevention Convention was held in the Parliament Buildings, Toronto, on August 30, 1918. Although technically a Provincial Convention, it can hardly fail in the sequel to affect the whole of Canada.

The convention was called by Sir William Hearst, Premier of Ontario, for the purpose of forming a Provincial Fire Prevention League to promote public education in fire prevention and of co-operating with the Government for the reduction of the fire waste. In his opening address, Sir William made it clear that the Government realizes the bearing of fire prevention upon the larger social problems of the day. He said:

"The returns for the last six months show a loss in Ontario of over $7,000,000, including the destruction in whole or part, of 3,456 buildings, at a time when the housing of people is one of the most serious problems we have to meet. We are trying to devise ways and means of overcoming the housing shortage in all sections of the Province of Ontario, yet, taking six months' record, and applying it to the whole year, 7,000 houses will be destroyed by fire. Taking these at five inhabitants to a house, it means that homes for 35,000 of our people will be destroyed during the year. In these days of food shortage, the loss by fire in Ontario during the last six months of 330 barns and 601 mercantile stores, with their contents, valued at over two million dollars, is well-nigh alarming."

It is interesting to note that Attorney-General I. B. Lucas, who spoke immediately after the Premier, laid stress upon the importance of the municipality in fire prevention work. He deprecated any attempt to force drastic legislation in advance of public opinion, but was in favor of laws of a permissive character, enabling the various municipal authorities to keep pace with the progress in public sentiment within their jurisdictions. He saw no objection, however, to a thoroughly drastic enforcement of fire prevention by-laws once they had been thus locally adopted.

Among the organizations represented at the convention was our member, the Dominion Association of Fire Chiefs. Chief J. S. France (Member N. F. P. A.) announced that the Dominion Association had formed a Fire Prevention Bureau within its own organization, and urged the desirability of close co-operation between the Fire Chiefs and the Fire Marshal's office.

Deputy Fire Marshal George F. Lewis (Member N. F. P. A.) read a useful paper on the general subject of the prevention of fires, drawing

special attention to the somewhat neglected problems of the protection of farm produce. The Fire Marshal's Office is endeavoring particularly to reduce the losses due to inadequate protection against lightning and to spontaneous combustion in barns resulting from poor ventilation and ignorance of the precautions that should be taken before storage.

Another very important point was raised in connection with the enforcement of the by-laws already in force. Mr. J. W. Wilson, of the Canadian Fire Underwriters' Association, cited instances of the temporary rescission of good by-laws to enable certain individuals or groups to erect buildings of a type that would not ordinarily be permitted. In one case a City Council, at the request of the local Ministerial Association, suspended the by-laws, notwithstanding the opposition of the Fire Committee of the city, so as to allow the erection of a frame building, 180 feet by 80 feet, heated by six coal stoves. Mr. Wilson suggested that the Provincial Government or some other duly constituted body should be invested with powers of approval and veto with respect to the enactment and alteration of building by-laws. Mr. Grove Smith later mentioned several large recent fires in the city of Ottawa, including one fatal fire in a hospital, and showed how each of them owed its disastrous character either to defective by-laws or neglect to enforce by-laws already enacted. Emphasizing the point made by Mr. Wilson, he stated that he knew of thirty-six instances during the last three years, in four towns within 15 miles of Toronto, of the abrogation and amendment of by-laws to allow influential citizens "to erect buildings as they would"; of fourteen motion picture establishments within 100 miles of Toronto that were not in conformity with the Provincial law, and of four hotels in the same area which also failed to measure up to the standards enacted by the Legislature.

A series of resolutions very similar in general purport to the annual "platform" of the N. F. P. A., but with modifications and additions appropriate to local conditions, was brought in by the Committee on Resolutions, of which Mr. John B. Laidlaw (Member N. F. P. A.) was chairman. After these had been passed, a further resolution was carried urging the Government, through the Forestry Department, to clear land at certain strategic points in Northern Ontario in such a manner as to hinder the spread of forest fires.

The interest of the women of Ontario was made manifest by the attendance at the convention of Miss Helen MacMurchy, who spoke of the relation between incendiary fires and the neglect of the feeble-minded; of Mrs. Cummings, who tendered the co-operation of the National Council of Women in the distribution of fire prevention literature in the homes of the Province; and of Mrs. John B. Laidlaw, who urged that the Department of Education take up the matter of teaching fire prevention in the schools, and who mentioned the hazardous conditions created by the dumping of waste paper and other rubbish underneath the stairs of certain schools known to her and the failure of individual protests as a means of inducing the authorities to do anything to remedy conditions.

At the conclusion of the convention, the Ontario Fire Prevention League was formed, with Mr. George F. Lewis as Secretary and Treas-

urer. The League is affiliated with the Fire Marshal's Office, and seems admirably designed, through the medium of its District Committees working in conjunction with the Central Committees of the organization, to arouse and focus the interest of the people of Ontario upon all measures that may from time to time be considered necessary in the interests of fire prevention and protection.

Fire Prevention Exhibition Suggestions.

By C. Albert Gasser
(Member N. F. P. A.)

An attractive Fire Prevention Exhibition can be very easily arranged. It is not a question of money, but rather the expenditure of a little energy and thought necessary in carrying out ideas.

A few suggestions are submitted herewith, any one of which or any combination of which will certainly repay the exhibitor.

Any office, room or corridor will serve the purpose or a vacant store may be utilized. A public school auditorium will prove an ideal place.

A few flat-top desks or tables must be available or counter-like fixtures may be arranged. A few standards of light construction covered with green burlap may be used to advantage in displaying photographs. This is practically all that is needed.

To make any kind of a showing, it will be wise to gather together a lot of fire relics for six or eight weeks before the date of the exhibition.

How many fires in your city were due to matches last year? Let's say 201. Good enough! Now get 201 matches and see that each one is partly burned. Get a board large enough, and on this board paste or glue these 201 partly burned matches, half an inch apart. A sign goes with this exhibit; something like this: "Every one of these 201 matches represents a fire due to careless use of matches in 1917. The loss was $500,000. Be careful with matches. Break them after using."

An oil lamp, a half-burned candle, an oil heater, some faulty gas tubing, some exploded oil cans, these and similar articles should be exhibited, each one labeled with the story of the particular fire in which it figured.

Table A. Moving picture paraphernalia, including films, reels, containers, carbons, a moving picture machine, a booth properly equipped, some burned film, some photographs of moving picture theatre fires (get these out of magazines and mount them on cardboard), literature of all kinds, including rules for operators, application blanks and license cards. With a little thought, this moving picture display can be made most interesting, bearing in mind that the average person likes "movies" but doesn't know anything about their details.

Fig. 1. Exhibit "E". How Captain Gasser educates the people of Newark in regard to Christmas Hazards.

Table B. Garage regulations. Build a little, one-story wooden garage with a wooden floor. See that the floor is thoroughly soaked with oil. Use sawdust to mop up the oil. Throw oily waste around. Put a little toy automobile in it. Put a few parts in water to represent "cleaning with gasoline." Illustrate every violation that you can think of, not forgetting to throw a cigarette butt and three or four half-burned matches on the floor. Now build another garage of metal or brick or hollow tile with a cement floor—asbestos shingles may represent a cement floor. Have fire pails, extinguishers, metal can for waste, sand to catch oil drippings, "No Smoking" signs—in short, make this a perfect garage. Have typewritten on cards or printed on signs the story which is being illustrated.

In this connection exhibit faulty gasoline containers and an underground tank, with literature showing the safest way of storing gasoline. Get some non-explosive cans of various sizes. Have some "No Smoking" signs. Put up photographs of garage fires, statistics of such fires and their causes and literature of all kinds bearing upon garages and gasoline hazards.

Table C. In bottles, jars or any sort of containers, exhibit samples of articles used or manufactured in your city. The work of gathering such samples is as fascinating as collecting stamps or coins. Each bottle should be labeled. By way of suggestion only, the following articles are mentioned: smokeless powder, black powder, celluloid, solu-

Fig. 2. Exhibit "F". "The Bonfire Nuisance."

ble gun cotton, dye stuffs, picric acid, gasoline, camphor, metallic sodium, naphthalene, nitrate of soda, barium, fireproofing solutions, coal tar, oakum, chlorate of potash and anything and everything, because practically everything enters into the study of fire prevention. A dozen bottles of samples will prove interesting and four or five hundred will be really worth while. If there are enough bottles, place them on a table in formation to spell the word "Fire."

Table D. Illustrate the dangers of cleaning clothes with gasoline. Get a wash tub and fill it with water. Put a dress or some article of clothing in it. Have an open dish, filled with water and in this put a pair of white gloves. Photographs and literature concerning gasoline hazards should be displayed. At this table it is well to exhibit a gasoline lighting apparatus, especially one that has exploded in an actual fire. Gasoline oil stoves also form a part of this display. The man in charge here must be prepared, of course, to talk intelligently to visitors, of static electricity in cleaning clothes and of the dangers of gasoline and its vapors generally.

Table E. Christmas dangers. Here's an opportunity for a pretty display. There must be two small trees, one a dry pine needle tree, in an ordinary holder, trimmed with candles and inflammable stuff, surrounded by cotton batting for snow and marked "Condemned." Then a tree in a pot of moist earth, *minus* candles, cotton batting and inflammable trimmings, but using a flame-proof snow, which is nothing but

Fig. 3. Exhibit "G." Kitchen Hazards.

ground mica, at ten cents a box. Put a chain of small Christmas tree electric lights on it and mark it all "Approved." A few dolls, some strike-anywhere matches, some safety matches, a handy pail of water and a lot of "Christmas Warnings" and "Christmas Dont's" will complete this feature nicely.

Table F. The bonfire nuisance can be very quickly illustrated. Some paper, dried leaves, a few sticks of wood, a lot of loose matches and a sign "The school-boy's delight—the bonfire" will direct attention to a serious municipal evil. Statistics to show the number of children burned to death at bonfires and showing how fires of this kind communicate to fences and buildings will be of added interest. It might be well to get together two or three piles of rubbish and dried brush and drive home the general hazard of these outdoor fires.

Exhibit G. Kitchen Hazards. If properly done, this will be the most attractive of all. First, a dirty kitchen. Get an old wooden mantle and an old kitchen stove on a wooden floor. Amputate one of the stove legs and prop up the stove with chunks of wood. Put wood in the oven, ashes in a wooden box or pasteboard box, rubbish back of the stove, clothes hanging on a line back of the stove under the mantle shelf, a kerosene oil can nearby, matches on the floor, shelf paper on the mantle, and decorate the mantle with benzine stove polish, a bottle of gasoline, an unprotected candle, strike-anywhere matches (loose) pipes and cigar and cigarette butts, a swinging gas bracket (and show

where mantle has been scorched). Secondly, a "model kitchen." A good four-legged kitchen stove, clean and tidy, a mantlepiece painted to represent brickwork, no clothes, no gasoline, no benzine, no rubbish, no ashes, no butts, no burnt matches, but instead, on the mantle shelf safety matches in a box, an ash tray for cigarettes, candle in a candlestick, and strike-anywhere matches in a glass dish. Appropriate signs are necessary. "Twenty-two violations of the rules of common sense—count 'em" is a good idea for the "dirty kitchen." Let the spectator pick out the violations just as he would the hidden animals in a jungle puzzle picture.

Exhibit H. A fireworks display should be included. This means an exhibition of firecrackers, roman candles, flower pots, and all the rest of this junk that used to be stylish. Dummies can be procured. Then have paper caps, sparklers and colored fire to present the safe and sane idea. Here's the place for all kinds of Fourth of July literature, the sort published by the N. F. P. A. fits in admirably. Blank cartridges and pistols of the deadly cast-iron type should be shown.

Shipyard Fire Protection.

Notes on the Organization of the Plant Protection Section of the Emergency Fleet Corporation.

By no means least among the war activities in which members of the National Fire Protection Association are taking a prominent part is the protection of the shipyards and plants working under the direction of the United States Shipping Board. The General Fire Marshal of the Emergency Fleet Corporation is Chief James McFall, who has for many years served in the councils of the N. F. P. A. as representative of the International Association of Fire Engineers; and a number of other members are engaged in various capacities in the Fire Marshal's and other branches of the Corporation's service. The method of organization and the instructions issued for the guidance of the officers engaged in the work of preventing and fighting fires in the shipyards are full of suggestion to those who are called upon to handle practical problems of fire protection on a large scale.

Under the general control and supervision of the General Fire Marshal are the District Fire Marshals attached to District Offices, from which, in their turn, they supervise the work of the Plant Fire Marshals employed by the various ship contractors. The principal duties of the General Fire Marshal are (1) to systematize and co-ordinate the activities of the various officers and employees concerned with matters of fire-fighting and fire prevention, (2) to visit and inspect shipyards and plants for the purpose of conferring and advising with the District Marshals as to the most effective methods of work, and (3) to deal with matters pertaining to the provision and installation of equipment and the estab-

lishment of methods of procedure in cases not coming within the jurisdiction of the district officials.

The general instructions to District and Plant Marshals are reproduced below, together with particulars as to the method of appointment and qualifications for the position of Plant Marshal:

(a. 2.) District Fire Marshals will be responsible for securing the carrying out of fire prevention and fire protection policy of the Emergency Fleet Corporation. District Fire Marshals are directed to make sure that each shipyard plant has in its immediate employ a suitably qualified Fire Marshal, to be known as the Plant Fire Marshal, to oversee the appointment of Plant Fire Marshals, to make sure that the various shipyard plants act promptly in the matter of these appointments, and that the men selected are qualified by training and experience for the positions.

District Fire Marshals will be required to make routine inspections at each yard, and will make such reports on these inspections as may from time to time be necessary. A detailed original report of the first inspection at each shipbuilding plant or yard will be filed with the General Fire Marshal. This report will include the number of day watchmen employed, the number of night watchmen, the number of day guards, the number of night guards; also, in the event of a paid fire department, the number of men regularly paid and of shipyard employee members; the qualifications of the plant fire marshal, with his previous fire department record. If the plant fire marshal has other duties in the shipyard, state the nature and extent of such duties. State what fire protection is obtainable from the local fire department, and method of transmitting alarms of fire in shipyard to department. What arrangements are provided for connecting up fire boat lines with yard main systems. Report in detail on the apparatus and equipment already provided for fire protection, including a list of fire hydrants, fire alarm system, the size of water mains, the source of supply, and any other equipment, arrangements, etc., that will tend to make a complete report on the local yard.

A duplicate of the report will be filed with the District Official in charge.

District Fire Marshals are directed to advise the Plant Protection Section immediately by telegram of all fires occurring within the plants or yards in their respective districts.

Routine reports on the fire prevention and fire fighting activities within the jurisdictions of the respective District Fire Marshals will be forwarded to the Fire Marshal's Branch of the Plant Protection Section at semi-monthly periods. Special reports will be filed with the various district officials as the latter may direct.

District Fire Marshals are directed to note that the problem of fire prevention is of equal importance with that of fire fighting and fire protection. To this end District Fire Marshals will instruct the Plant Fire Marshals of their respective jurisdictions in the matter of fire prevention procedure, emphasizing particularly the necessity of daily cleaning up of the premises in and around the buildings and hulls, the posting of orders prohibiting the accumulation of trash, chips, or other combustible debris.

(b. 1.) Plant Fire Marshals will be employees of the ship contractors. It is directed, however, that arrangements be made whereby the Plant Fire Marshals will carry out the instructions of the District Fire Marshals in the matter of fire prevention and fire protection measures.

(b. 2.) Plant Fire Marshals preferably should be men who have had at least five (5) years' experience in some well-organized, full-paid fire department, and should not be over 48 years of age. In the smaller yards he should be a man who has reached the grade of lieutenant or captain. In the larger and more important yards he should have reached the grade of chief or assistant chief of a fire department.

(b. 3) Plant Fire Marshals will supervise the care of all fire fighting equipment and appliances at the plants at which they are stationed, will develop and establish fire prevention procedure, organize and direct plant fire-fighting brigades.

Regular inspections must be made of all fire equipment and appliances to insure that the fire hydrants and fire pumps, when installed, are always in serviceable

condition; that hose is properly cared for and arranged for quick handling; that extinguishers are regularly inspected; water barrels and pails filled, the water in them not used for other than fire purposes; and in general that modern fire prevention methods are practiced.

For the plant fire brigades the necessary number of employees, either workmen, police or watchmen, will be organized into a strong and well-drilled fire-fighting organization for both day and night service; the number must be sufficient to handle effectively hose lines taken off the yard main system; must be regularly drilled in the handling of such lines, ladders and other fire equipment, and be able to assist effectively the city or town fire department which may respond to fires at the plant, or to fight a fire alone when no outside aid is available.

Plant Fire Marshal will make a weekly report to the District Fire Marshal showing condition of appliances and equipment in his yard; a resume of fire prevention work performed; the number of drills given; the number of day and night watchmen on duty, and a summary of conditions, with recommendations that will tend to increase the efficiency of the service. A summary of these weekly reports will be included in the semi-monthly reports to the Fire Marshal's Branch of the Plant Protection Section.

The Plant Fire Marshal will report immediately by wire to the District Fire Marshal all fires occurring at the plant where he is stationed. The Plant Fire Marshal will also prepare a written report on all fires at the plant at which he is stationed, and forward it to the District Office. A copy of this report will be forwarded at once to the Home Office. This report is to be prepared in narrative form, and will include the following information: the location of fire; how discovered; cause; how alarm was given; how fought; apparatus used; assistance rendered by city fire department; action of any sprinklers in building involved; cause of failure of plant fire protection system, if any; extent of fire, including probable damage to ships and to plant, supplies and materials; direction and velocity of wind; temperature, if unusual; condition of fire protection system and apparatus after fire; remarks, under which will be included pertinent points of interest and lessons to be gained from the fire; and recommendations to prevent, as far as possible, a recurrence of fire at the plant.

Fire Safety in Schools.

The three accompanying charts are developed from that published with Mr. Benjamin Richards' report appearing in the QUARTERLY for July, 1918, (page 50). We believe members will be interested to see the form in which the results of Mr. Richards' work are to be promulgated among the educators of America.

Chart I. Prevention of Fire.

Fire prevention for existing buildings is mostly a matter of maintenance the essentials of which are, (1) **Cleanliness,** (2) **Guarding** (care and preparation to prevent fire), (3) **Inspection,** to keep up efficiency of exit and fire apparatus.

Maintenance especially applies to **Fire Hazards.** Those called **Common** apply to property in general; the **Special** hazards pertain to the specific occupancy as a school.

For proposed buildings fire prevention demands attention to (1) **Location,** to avoid fires from exposing buildings and to procure adequate public fire fighting facilities and (2) **Construction.** This involves consideration of all building laws, fire prevention rules, approved materials, co-operation with fire protection specialists and strict attention to all structural details.

The chart indicates the specific items to be considered under the above outline.

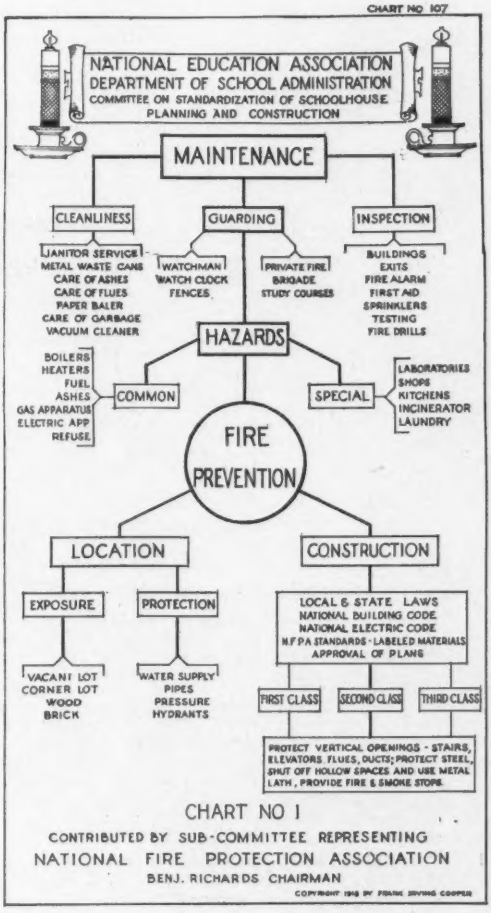


Chart II. Protection from Fire.

Maintenance and guarding the hazards apply as in fire prevention (Chart I).

Fire Protection demands:

I. **Outside** protection—means for fighting a fire in the school from the street and yard. This should consist of (1) **Private** apparatus, available for immediate use of the employees and (2) **Public** facilities as specified.

II. **Inside** protection which calls for the use of tested, approved devices. Inside protection consists of (1) **Fire Alarms**; manually operated for ordinary rooms and **Automatic** (thermostats) for the hazardous locations. (2) **Sprinklers: Outside,** on outer wall openings seriously exposed to fires from without and **Automatic** to cover the hazardous rooms. These latter must have a good water supply.

III. **First Aid or Hand Apparatus** for quenching fires when very small consisting of **Fire Pails, Chemical Extinguishers,** and **Stand Pipes** with hose each to cover locations as specified in the chart.

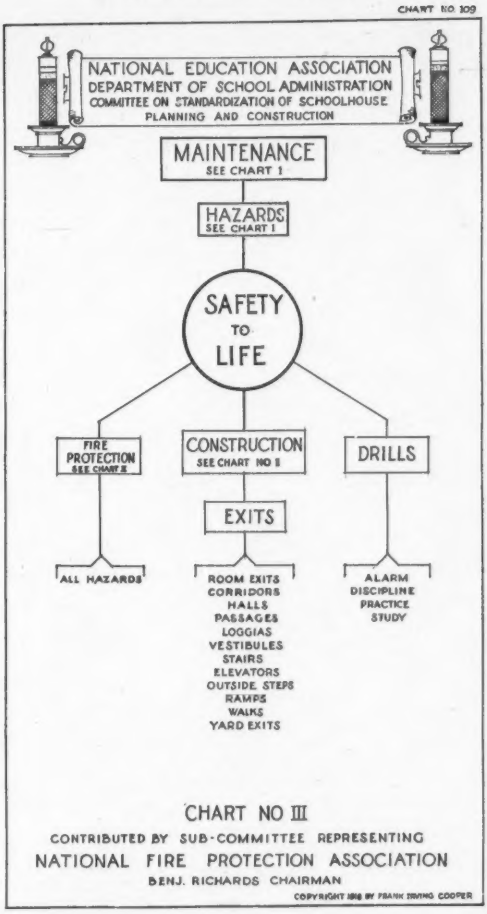


Chart III. Safety to Life.

Maintenance and guarding of hazards are essential to Safety to Life and also apply as in Charts I and II.

Safety to the inmates of the school is entirely dependent on the following three essentials

1. **Fire Protection** of the building, as specified in Chart II so that fires may be stopped before life is endangered.
2. **Construction** as specified in Chart I. Life safety is directly proportioned to the speed of burning. For safety to life certain details of **Exits** need attention which are not essential to fire protection of the building.
3. **Drills.** maintained to rapidly and safely empty the building of all occupants. The high efficiency of the Drill is most essential in schools having defects in the other specifications outlined on the three charts.

The destruction fire byof the steamship Lake Manitoba shown above, with a cargo of oil and coal, at Montreal on August 26, 1918, entailed a loss estimated at $1,500,000. The fire, which originated in the machine room, lasted several days.

The Fire Risk on Vessels.

By Samuel D. McComb

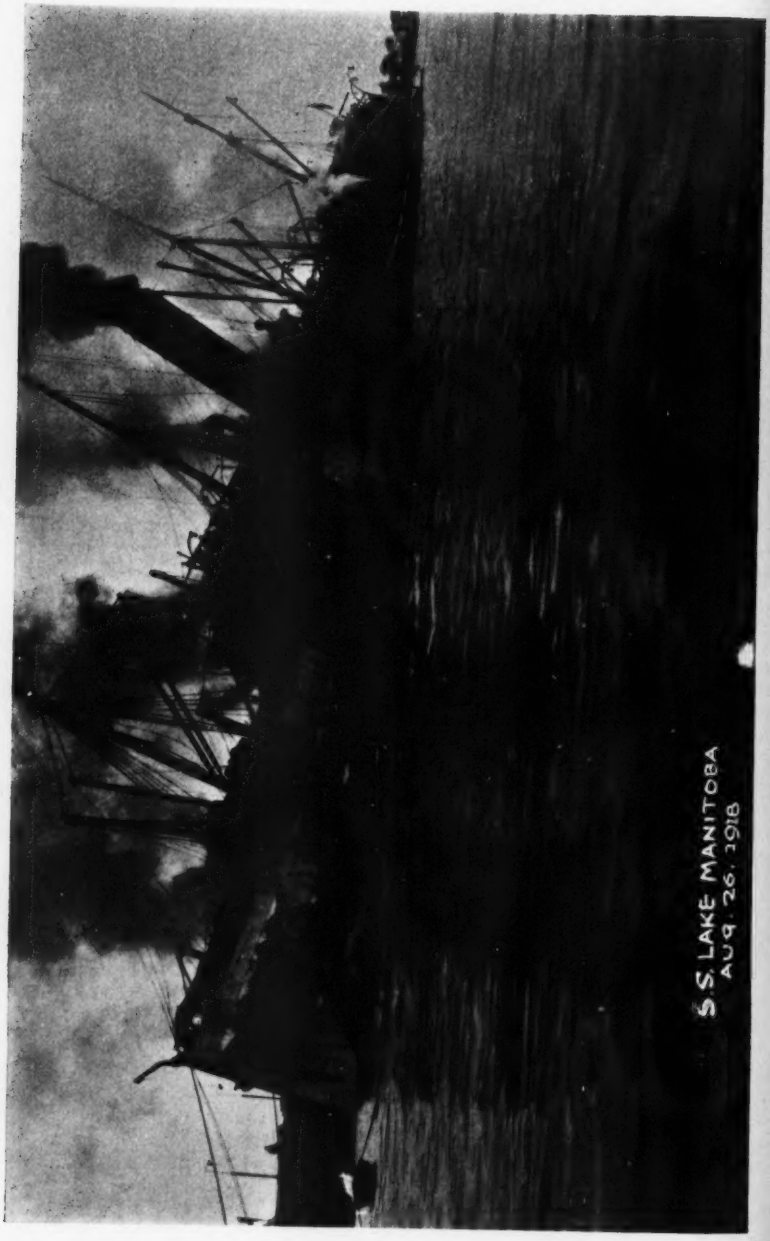
[This article is reprinted by courtesy of *The Weekly Underwriter* from a series of valuable studies appearing weekly in that journal and covering in a broad way all the hazards of marine transportation, so important at the present time.]

At this time, when the resources of the country are being used to their fullest extent to turn out tonnage, it is essential that the greatest care should be taken to preserve the ships that are already built. There have been a number of total losses by fire on ships this year which were of a preventable nature. Few people realize the extent of the damage done by fire to shipping annually. There are no statistics published showing the monetary loss, and only incomplete reports by the government and by different classification societies showing the number of vessels and tonnage which have been total losses. So far as the fire losses are concerned, with a little precaution most of them could have been avoided.

The ideal condition would be to have a vessel constructed entirely of incombustible material and carry only incombustible cargo, but while this, of course, is impossible, the condition can be reached very closely as far as the vessel itself is concerned. The subject of fire-resistive material has received much consideration, but it has not been used to any great extent. Sheet metal and asbestos preparations are replacing wood for interior work, but we are still using wood and other inflammable materials in the construction of our ships, and a large number of all-wood ships are now being built in all parts of the country. They should be constructed so that the probability of their catching fire is reduced to a minimum, and means should be furnished for promptly extinguishing a fire should one occur. From the standpoint of fire hazard, vessels can be divided into three general classes, namely, steam, gasoline and those with no power. The classes will be taken up separately, as the principal causes of fire and the methods of extinguishing them are different in each case.

On steam vessels, the principal ascertained causes of fire are (1) woodwork around uptake or stack igniting; (2) spontaneous combustion of coal; (3) fire originating in the cargo, and (4) from galley stoves, lamps and candles. Knowing how fires originate, we know the points which must be safeguarded to prevent them. It is of the utmost importance where a stack passes through a wooden deck that the opening be cut at least twelve inches clear all around and the wood be faced with asbestos and sheet-iron or steel. If forced draft is used and overheats the uptake and stack, further protection is needed—either the uptake and the base of the stack should be covered with cement or all the woodwork within a distance of three feet should be covered with sheet-

The destruction are by of the steamship Lake Manitoba shown above, with a cargo of oil and coal, at Montreal on August 26, 1918, entailed a loss estimated at $1,500,000. The fire, which originated in the machine room, is seen spouting from



Another view of the burning steamship Lake Manitoba. See page 132.

iron placed over asbestos. When covering a boiler, care should be taken along the sides of it; frequently the space between the boiler shell and bunkers is so small that it is difficult to make a good job, but in no case should this space be packed up with non-conducting material; some opening should always be left between the covering and the bunkers. On a leg boiler the covering on the sides of the fire-box should be carried right down to the floor; frequently it is stopped about the level of the grate bars, and an examination will show that the heat from the uncovered plates has charred the bunker boards alongside. A coaming should be placed at the front of boilers extending across the fire-room to prevent hot ashes getting between boiler and bunker sides. If the fire-room floor is laid on a wooden deck or wooden beams, asbestos should be put down first. Hot ashes have set fire to a wooden deck through four inches of cement. The same care that is used in protecting woodwork around the boilers should be used around the galley stove and stove-pipes. All wooden partitions in the back and at the sides of all galley stoves should be protected. Where possible, the floor should be brick or cement, but, if wood, it should be covered with sheet metal over asbestos extending out in front at least 2 feet 6 inches, and the stove should be securely fastened down. Most important of all is to have a metal hood over the stove or have the ceiling overhead covered with heavy asbestos, disastrous fires having been started by grease boiling over on the stove and blazing up, setting the woodwork overhead on fire. The stack from the stove should lead outdoors by the most direct route possible; on some old passenger steamers it has many turns and bends before it finally comes through the upper deck. When possible, the galley should be on the upper deck, but if placed in the hold care should be taken to run the stove pipe in such a manner that even though it get red hot it will not ignite the woodwork. In engine-rooms the method of carrying lubricating oils and waste needs attention. It is well to have the supply of oil as small as possible; where there is a large quantity on board the engineers are usually careless and extravagant with it, while, with a small supply, good care is taken to see that none is wasted. This not only saves money for the owners, but less oil is spilled about. All oil-cans should be carried in metal trays to catch the drip, and all wooden shelves on which oil is kept should be completely covered with metal having the edge turned up and all joints soldered. Large oil-cans should have self-closing faucets. No oil should be kept in partially filled barrels; when a barrel is opened, it should be emptied at once.

Metal receptacles with rolled joints should be provided for carrying waste. It is quite common to carry waste in burlap bags, placed frequently near the oil supply, so that it gets saturated with leaking oil. It appears difficult to impress on engineers the danger from spontaneous combustion from oily waste, though fierce fires are caused by it.

Lamps have been a fruitful cause of fire on ship-board. Glass lamps frequently break or crack, and should never be used. All lamps should have metal bodies and they should be secured in their sockets with clips or some device which will prevent their coming out when the vessel rolls. They should be carried in substantial wall brackets or suspended from the ceiling, and be well stayed to prevent swaying. It

Another view of the burning steamship Lake Manitoba. See page 132.

is a custom on many vessels to use common table lamps, which are very easily upset by the vessel striking something or rolling heavily, and their use should be prohibited. A steam lighter on Long Island Sound collided with a sailing vessel; the shock upset a table lamp in the house aft. All the crew rushed to the bow to see what damage had been done, and the fire started by the overturned lamp was not noticed until it had gained great headway. The crew were compelled to abandon the vessel, which was totally destroyed. Lamps should always have proper shields to protect the woodwork over them. It is common to see the paint over a lamp scorched and blistered. One may be left burning when no person is around, and a fire start and get beyond control before it is noticed. Owners should impress on their masters the necessity of taking care of lamps properly. Lamp rooms are required by law to be lined with sheet metal, and in addition to this they should be made absolutely oil-tight on the bottom and for at least a foot up on the sides, all laps and all nail holes being soldered over; and any openings in the floor for pipes or rods should have a collar or flange round them to prevent leakage of oil.

In the lamp room of a large steamer a 3-inch hole was punched in the floor for the steam extinguisher pipe. An oil barrel in the room sprung a leak, and the oil ran through the opening and spoiled a quantity of wheat in the hold. Had this oil ignited it is improbable that the vessel could have been saved. When electric lights are used, the installation of the wires and fixtures should receive careful attention. Of necessity the wire runs in many inaccessible places, and a fire caused by defective wiring may be difficult to locate. All wires in the hold, in engine and boiler spaces, where cargo is carried on main deck and outdoors, should be in iron conduit; switchboards should be of slate or other non-inflammable material and well clear of the woodwork back of them, and if the bulkhead is wood it should be covered with heavy asbestos or a steel plate, or both. The writer has seen on a large passenger steamer a yellow pine switchboard placed against a yellow pine bulkhead; needless to say, it started a fire. It is probably impossible to prevent the use of torches in the engine and boiler rooms, but the man in charge should be cautioned to see that they are carefully used and not left about when lighted. Fires from this cause are numerous—in one instance a lighted torch was left hanging on a wooden stanchion; in another instance on the top of a boiler; again, alongside an oil barrel, and so on. Engineers must be impressed with the necessity of extreme caution in this respect. Though the practice of using torches by the engineers and firemen cannot be prevented, the use of torches and candles by stevedores and cargo trimmers can and should be stopped; only closed lanterns or incandescent lights should be allowed in the hold of a vessel.

The most hazardous type of steam vessel and one that for structural reasons always will be dangerous from a fire standpoint is the wooden tug-boat. For ease in maneuvering, to get around docks quickly and to turn in a small space, it is desirable to have a tug small; to tow heavy loads and move large vessels it is necessary to have it powerful. The result is a boat as small as can be designed to carry the machinery powerful enough to do the work required, the boiler usually being the largest size that can be installed, and just as close to the woodwork as

the law permits. To allow an ample passageway on deck on each side, the house is made narrow—so the boiler is entirely surrounded by woodwork placed as closely as possible to it. To make matters worse, on board the average tug there is a platform or grating over the boiler where wet lines are placed to be dried out. Dirty clothes and overalls are kept there, and frequently even cans of oil. Inside the house, over the boiler where the ventilation is poor, the heat becomes excessive, and the woodwork around the stack is ignited, or, where there is a tight platform fitted, the bunker sides will catch fire. A large percentage of the tug-boat fires originate in this way, and they could all be prevented if good air space was left all around the boiler and proper ventilation was provided over it to allow the hot air to escape. Many stack umbrellas have a flange on the outer edge which projects below the deck coaming, so that the hot air and gases after rising above the coaming must come down again around the flange of the umbrella.

It is the opinion of the writer that with construction of this kind the hot air and gases come up against the under side of the umbrella and stay there. In order to provide effective ventilation, the lower edge of the flange should be above the upper edge of the coaming.

The galley stove is generally in a cramped location, and all the woodwork around it should be especially well protected. These are the two points that require most attention in tug-boats, and the smaller the tug the greater the need of care and caution.

Freight steamers are also a hazardous class. There is not only all the danger inherent in the vessel itself, but also the danger from fires originating in the cargo. It is impossible to lay down any set of rules for promptly extinguishing a cargo fire, for both the cargoes and the vessels carrying them are so varied, ranging from a deep-draught steel vessel carrying iron ore in the hold to a shallow-draught wooden river steamer carrying a deck load of cotton; most numerous, though, are general cargoes. For the safety of ships in the event of an injury, water-tight bulkheads are required in the hold, and these act as fire walls tending to confine a fire to the compartment in which it starts. Every compartment should be fitted with a pipe running to the pilot-house, and air should be drawn from these pipes continuously. A fire starting in the hold could be promptly detected from the smoke issuing from the pipe, which would also show exactly in which compartment the fire was located. In addition, each compartment should be fitted with a steam fire extinguisher, so that steam could be turned on immediately when the fire was discovered. The cost of installing steam-pipes is small, and at least one should be fitted to every subdivision of the hold; where the length of these exceed 50 feet, two steam-pipes should be fitted. That is the best means of effectually extinguishing a blaze below decks, as the steam can reach every portion of the hold and smother the fire. To attempt to use a hose would necessitate lifting the hatch covers, thus admitting fresh air. This additional supply of oxygen would cause a smouldering fire to burst out and probably get beyond control.

Steam extinguishers cannot be used on the main deck, as there is no confined space to hold the steam, nor can lines of hose always be depended upon, as the entire space may be filled with package freight,

and the fire may start somewhere near the middle of it, being absolutely inaccessible. The best means of extinguishing a fire of this type is a sprinkler system. Many of the newer boats are so equipped, but most are not. Every vessel carrying cargo on the main deck should have sprinklers. A poor installation is about as good as none, and when sprinklers are put in they should cover the vessel completely from stem to stern and be placed close together, otherwise a fire might break out at a point not covered by the sprinklers and gain such headway by the time they opened that it could not be controlled. Fires in general cargoes are the most numerous, arising from spontaneous combustion due to overheating, or by chemical action through the mixture of different substances that may have escaped from their packages. It is impossible for the stevedores to know the contents of every package put on board, but where anything is known to be likely to cause fire, it should be placed so that the hazard is reduced to a minimum.

Classes of Vessels.

Coal, oil, hay, cotton, jute and hemp all constitute dangerous cargoes, and vessels carrying them should be especially well equipped with fire apparatus.

The finest vessels we have are the passenger steamers, and these are being constructed better, more costly, and more nearly fireproof every year, but the danger of fire is ever present. We see advertisements in the daily papers of certain steamers: "They cannot sink, they cannot burn"; "absolutely fireproof," etc., but should a fire once get headway, there will be little left of the vessel. On account of their less rigid construction the shallow-draught river steamers cannot stand as severe a fire on board as the deep-draught vessels. They are braced with hog-chains and tie-rods and, should the supporting woodwork collapse, the vessel is likely to break in two. Designers and builders of this type of vessel should consider such a contingency when arranging the longitudinal stiffeners.

The government inspection on this class has improved somewhat in recent years and owners are taking more care, but there is room for improvement.

There is one type of vessel on which there is no government inspection or supervision whatever, and on which the fire losses have been numerous and heavy, namely, contractor's plants consisting of dredges, pile drivers, floating derricks, drills, etc. While all the general notes on construction given above are applicable to these craft, there are some points of special importance. Usually over the boilers there is a dome built which has slat partitions around for ventilation. These slats are generally made so that the upper side of one is higher than the lower side of the one above it, with the result that there is very little, if any, ventilation. The slats should be arranged having a clear horizontal space between them. The writer investigated five fires on dredges all occurring within a short time of each other, two of which were on the same dredge, a machine which had just been built at a cost of $100,000. All five fires started in exactly the same way. According to witnesses, there was a slight explosion, and instantly the whole dome seemed to be in flame from end to end. In one instance, where the fire had been ex-

tinguished very promptly, the inside of the dome was scorched all over, but no one place very badly burned, showing that the fire had not started at one point and spread, but that the dome had been ignited all over simultaneously. The inference was that certain gases escaped either through a leak in the uptake or while the boilers were being fired, and had risen to the under side of the dome and remained there, and had then been ignited by a flame from the furnace door while the fires were being raked. Hot air and gases will not descend, and all ventilators and openings made for their escape should be so constructed that this is not necessary. On account of the number of gears, chains and cables which require slushing or lubricating, the amount of lubricants carried on these machines is usually large, and little care or attention is given to where or how they are carried. It is not uncommon to see a number of partially filled barrels of oil standing alongside of a boiler, with perhaps a burlap sack of waste on the deck near by. When the danger of this is pointed out to the captain, he will usually reply that he is too busy to pay attention to such details, or there is no other place on board to carry the oil, or he may promise to rectify the condition, and afterwards forget it. As a general thing, these machines work in isolated places, or where it is difficult to reach them, and if the superintendent or captain is making satisfactory progress the owners will not visit often, and when they do it will be to inspect the work being done rather than to examine the machine doing it. There are some firms which keep all their property in first-class order and properly equipped, but on the majority of machines there is evidence of carelessness and disregard of the dangers of fire, and the appliances are insufficient to cope with an outbreak. In some cases there is not even a bucket with which to extinguish a fire, and if one started it would surely result in a total loss.

Fire Extinguishers.

Now, in regard to fire extinguishing appliances generally, the most important point to bear in mind is that when these are needed they are needed badly and quickly. Many owners do not realize this, rather considering the equipment they are compelled to install as a legal requirement, and they put the necessary items on board with no regard to where or how they are placed. All vessels should be so equipped that every part of them can be reached promptly and effectively by fire appliances. It is an easy matter to extinguish a fire in its incipiency, but flames gain headway rapidly and in a short time are beyond control of the best apparatus; therefore, every second counts. Fire appliances should be accessible and ready for instant use. The time lost in coupling up a hose which should have been connected may cause the loss of a ship. Approved extinguishers should be carried in every pilot-house and in every galley. When a fire is discovered it is always reported to the man in the pilot-house, and if he has an extinguisher right at hand he can get to the fire and use it at once. A fire starting in the galley, especially from grease spilling on the stove, is always a dangerous one, but if an extinguisher can be used instantly it can probably be controlled. In addition, on large vessels, extinguishers should always be carried in the crew's quarters, and on passenger steamers they should be placed in the main saloon and in passageways for use in the event of the draperies catching fire.

There are many worthless extinguishers on the market, which are sold only because they are cheap, and it is advisable to purchase only such makes as have been tested and approved.

It should be borne in mind that an extinguisher is not a fire department; its capacity is limited, and unless used promptly it is not effective. When a fire attains a size beyond the control of an extinguisher, it becomes necessary to use hose. All steam vessels should have a steam pump and a hand-pump, and these should be connected to the same main, the hand-pump for use in case the steam is not up or the steam pump out of order. In no case, even on the smallest boats, should there be less than two lengths of hose, as the fire might start just at the place where one length was kept, and render it useless. The fire main should extend to every deck, and the plugs on it should be located not more than 75 feet apart. Vessels of larger size should have a main on each side. The hose should in no case be less than 1½ inches in diameter—on many small boats at the present time 1-inch hose is used, but experience has shown that this is of no practical value. On larger vessels regular 2½-inch corporation hose should be used. Hose should always be kept connected. The law requires this on passenger steamers, but on other vessels it is the regular custom to have it uncoupled, and it is frequently kept in the hold. This is bad for two reasons—first, the hose probably cannot be found when wanted; and secondly, the threads on the pipe will be filled with dirt or painted over, causing delay in connecting the hose after it is found.

In addition to being thoroughly equipped with extinguishers and hose, all steamers carrying cargo should, as already mentioned, have steam extinguishers in the hold and sprinklers between decks. Passenger steamers should all be thoroughly sprinklered, those having sleeping accommodations having a sprinkler in every stateroom. Thermostats or some type of automatic fire alarm should be fitted. On passenger steamers over 300 feet long, fire walls should be built every 150 to 200 feet, extending from the main deck to the dome. These walls should be constructed of wood at least 1½ inches thick (two thicknesses of ¾-inch tongued and grooved wood laid diagonally), covered on each side with at least ⅛-inch asbestos having sheet-iron over it. The openings in these walls should be as few as possible, and should be fitted with regular fire-doors which can be closed instantly.

Gasoline Boats.

Gasoline is, of course, the great hazard on these boats. The vibration caused by the motor in time loosens the joints in the piping and gasoline leaks into the bilge; a certain amount also leaks out at the carbureter. As there is always more or less bilge water in the bottom, unless water-tight bulkheads are fitted there is a film of gasoline floating on the bilge the entire length of the boat, and this, if ignited, will spread fire all over instantly.

Safe Construction.

Some years ago a firm constructed launches having the tank in the bow, with a water-tight bulkhead back of it; holes were bored in the planking on each side of the tank just below the water-line, allowing

free circulation of water around the tank, the feed-pipes came out of the bottom and ran along the keel to the engine, which was at the aft end. Forward of the engine was a water-tight bulkhead extending above the water-line, and the entire engine compartment was lined with brass. If there was a cabin on the launch it ended forward of the engine, which was left in the open so that no vapor got inside of the boat at all. This was the safest possible construction.

Watertight Compartments.

The tank and the engine should both be in water-tight compartments, even though the bulkheads at each end of the engine only came up to the floor boards—and the feed-pipe should be run outside the hull. This will prevent leaking gasoline and oils from flowing the entire length of the boat. All cabin-boats should have ventilators to carry off the vapor. Many motor boats are owned by business men, who use them only on week-ends, so they remain locked up tight from Sunday or Monday until the following Saturday. If any gasoline is escaping the entire cabin becomes filled with a highly explosive vapor, which may blow the boat to pieces. Many persons have been killed from this cause, to say nothing of the loss of the boats. Fires are frequently caused by gasoline cooking stoves. Only stoves of an approved type should be installed, and the woodwork around them should be protected and no curtains should be hung near them. The main tank on the boat and the tank for the stove should be filled by daylight only and away from a flame of any kind. On motor boats carrying passengers for hire, smoking should be prohibited, as this has caused many disasters.

Extinguishing Fires.

The problem of extinguishing fires on motor boats is a difficult one, as entire dependence has to be placed on extinguishers. If the draperies or woodwork catch fire, the average approved extinguisher can handle it, but if the gasoline on the bilge water is ignited, and there are no bulkheads, the entire boat will instantly be in flames, and if there is any quantity of gasoline it is doubtful if any motor boat carries sufficient equipment to extinguish it. The law reads that every motor boat should "carry ready for immediate use the means of promptly and effectually extinguishing burning gasoline." The act does not specify what will do this, but on June 9, 1910, the Department of Commerce and Labor issued a circular in reference to the act, which contains the following paragraph:

> "No specific means of promptly and effectually extinguishing burning gasoline are prescribed. Besides the usual fire extinguishers, suitable chemicals or bags of coarse flour or sand will serve the purpose."

Imagine a man, relying on this government circular, taking his wife and children out in a motor boat with nothing but a bag of flour (itself very inflammable) to promptly and effectually extinguish burning gasoline floating on bilge water!

Boats Without Power.

The hazards due to means of heating and lighting require the same attention on this class as on other classes of boats, but the two principal dangers are fires originating in the cargo and exposure fires. When

there is a donkey boiler, steam fire pumps should be fitted and a hand-pump connected to hose on each end of the boat should always be installed. There should be a liberal supply of buckets with draw lines attached, so that they can be dropped overboard and refilled. Boats of this class are used largely as lighters or transfers; they are moored alongside docks, warehouses or large steamers being loaded or unloaded, and often so surrounded by similar craft that they cannot be moved until the others have first been taken out of the way. They are exposed to any fire that may start around them, and are helpless. A number of disastrous fires of this kind have occurred. The men in charge of all docks should use care in maintaining an arrangement which will permit all the boats to be moved promptly. At the present time, with the large amount of goods stored on piers and lighters and the necessity of conserving everything, greater care than ever should be exercised.

Boats Laid Up.

Another important point which should receive more consideration from owners of all types of vessels is the care of vessels when laid up out of commission. Too many, especially those which have not been profitable, are simply moored at an out-of-the-way dock and left until wanted again.

Watchmen Needed.

All vessels or groups of vessels should be under charge of watchmen day and night to keep off thieves and tramps, who have caused many fires. Whenever possible, boats should be laid up under city fire protection at a place where fire engines can readily reach them, and the man in charge should know the location of the nearest alarm box. Where a number of boats are laid up together, sufficient space should be kept between them so that they do not expose each other; 100 to 150 feet is a safe distance. If there is not sufficient room to admit of this, they should be so moored that they can be cast loose readily and taken out of danger. Every winter instances occur of several boats being burned by a fire starting on one, and this is a loss which is entirely preventable.

On the large and more valuable steamers, steam should be kept on the donkey boiler when the boat is out of commission, permitting the hose and sprinkler system to be in constant readiness for use.

Cleanliness Essential.

Owners and managers can do much to reduce the fire loss if they insist on captains keeping the boats clean and having the necessary fire apparatus installed and frequent drills. Unless the crew know just what to do in case of fire and everything is in perfect working order, there is likely to be disorder on a boat when a fire breaks out. In some cases the fire pumps have been out of order or the hose mislaid, and a disastrous fire has resulted. Where the management demands and sees that proper upkeep is maintained, duties properly performed and frequent fire drills held, the sounding of the fire alarm will bring out a well-drilled crew, properly equipped, and they will generally get the best of a fire.

How Some Important Ship Fires Were Fought.*

With Notes on Tools For Marine Fire-Fighting.

By Edward J. Worth,

Deputy Chief Commanding Marine Division, New York Fire Department.

The steamship *Conastoga,* of 8,000 tons, was loaded with a general cargo in the two holds and after 'tween-decks compartments, extending almost to the stern of the ship. In loading the 'tween-decks the tiers of cargo were topped off with cakes of parafine wax wrapped in burlap. The fire originated in this wax from some unknown cause, melting it and causing the burning wax to run down among the cargo, igniting everything below.

The fire was showing in No. 3 and 4 hatches, to which point lines of hose were quickly stretched to prevent the fire from spreading to the piers. Streams were also directed to bulkheads on both sides of the burning compartment, and the clamps were removed from doors leading from the main to the 'tween-deck compartment, which was also threatened by the fire. Lines of hose with open butts were stretched to this compartment and water started, flooding it to the top of the door sills. This prevented the fire from igniting the cargo resting on steel decks over the seat of the fire.

In the compartment directly forward of the one on fire were stowed 4,000 cases of gasoline with a half-inch steel bulkhead between. It was necessary to keep this bulkhead cool at all hazards. This was done by stretching two 3½-inch lines of hose from the boat's turrets to the deck of the ship; two 3-way gate connections (3½ inches to 2½ inches) were connected to these lines; six lines of 2½-inch hose with 1¼-inch nozzles were stretched from these connections, and the water was started for the purpose of cooling down the bulkheads, the deck plates and the sides of the ship, which had begun to buckle from the intense heat caused by the burning wax.

The oxygen cutting torch was put to work, and about ten small holes were burned in the deck over the fire, and streams of water from distributors, or cellar pipes, were directed through these holes to extinguish the fire in the 'tween-decks.

The ship's steam winches were used for hoisting out part of the cargo for the purpose of overhauling and to complete the work of extinguishing the fire.

*From a paper presented to the International Association of Fire Engineers.

In my opinion had it not been for the oxygen cutting torch it would have been almost impossible to check this fire without flooding the entire compartment.

The steamship *Preston,* of 5,000 tons, was anchored north of Liberty Island. Fire broke out in the forward compartment, which comprised No. 1 and 2 hatches; there being no bulkheads between them, the fire followed the line of the foremast up from below. The compartment contained a general cargo, and the fire extended to the coal bunkers, which were in the wings of the ship, separated from the cargo by wooden bulkheads.

Lines were stretched from the fireboats to the deck of the ship; the ventilators on a line with the wooden bulkheads were removed, and the lines with distributors attached were dropped down to prevent the fire from spreading any further aft. Additional lines with controlling nozzles attached were stretched to the hatch openings and directed to the wings of the ship and on a line with the foremast, where the bulk of the fire was.

We removed the ventilators at the forward end of the compartment on fire, and lines of hose with spherical nozzles attached were dropped down through the openings in order to prevent the fire from extending through the watertight iron bulkhead into the fore-peak of the ship, which was occupied as paint lockers, chain lockers and sailors' quarters.

In spite of the strenuous efforts to cut off the fire, it was found to be extending and threatened the destruction of the ship. It was then decided to raise the anchor and move the ship to the south of Liberty Island, where there is shallow water with a soft bottom, for the purpose of flooding the hold.

The ship proceeded under her own steam, assisted by the fireboats, to the beaching grounds and dropped anchor in four fathoms (24 feet) of water, which was sufficient under the keel of the ship to allow her to settle at mean tide, leaving her main deck awash. Additional lines were then stretched from the fireboat to the open hatches of the compartment, using 3½-inch open butts. Water was started, flooding the compartment in a comparatively short time. The ship settled down in the soft mud bottom, leaving the coamings of the hatches just above water, and extinguishing the fire throughout the ship.

Owing to the lack of bulkheads to stop the fire, it was absolutely necessary to put the ship down, to save the ship from destruction and salvage the cargo. The ship was pumped out by a wrecking company, and was discharging the damaged cargo fifteen hours after the fire.

Among the valuable appliances needed in fighting ship fires are smoke helmets. These have enabled firemen to enter the holds of vessels which were heavily charged with smoke and fumes, and to do good execution with a 2½-inch line—in many cases extinguishing the fires.

The value of the oxygen cutting torch has already been mentioned. It is very often necessary to cut holes in the deck plates and bulkheads of ships to admit distributors or cellar pipes, especially where red heat shows and when it is impossible to send men into the hold to direct streams between the cargo and deck plates, owing to the intense smoke and heat and to the stowing of the cargo close up to the deck plates.

Hook ladders for hanging on the rail of a vessel or over the hatch coamings; tower pipes, acting like water towers at land fires; rail pipes for holding a stream at any desired angle on fires under piers and in floating debris, and for cooling the sides of burning vessels; the 3-way gate connection for the independent control of several lines of hose; pipe holders for handling heavily charged lines of hose; rivet cutters; spray nozzles for wetting down fibre cargoes; powerful searchlights and electric hand lights—these are indispensable tools in marine fire-fighting.

The Smoke Helmet

The smoke helmet is not carried on any of the New York fireboats, but has taken part in so many of our ship fires that it is worth while mentioning. These helmets are carried by the Rescue Company, and can be brought to the scene of any fire by sending in a special call for this Rescue Company from the nearest street box.

Over-confidence on the part of men operating with helmets must be avoided, and they should be used only by men who have had wide experience as firemen, for the reason that it is possible to go into the densest smoke or fumes without ill effects to breathing, and an untrained man might go too far for safety; they must be able to use all senses without being able to see—always be on the alert—and the senses of hearing and feeling must be keen, as they surely will be if a man has had sufficient experience as a fireman.

Men should always operate in pairs in charge of an officer.

In dense smoke always use a guide line, which is also used as a signal line. A simple code of signals should be made up and practiced, such as:

1 pull on rope—send in more hose and signal line.
2 pulls—I am going up or down stairs (this will be known by existing conditions).
3 pulls—I am backing out (which when received by men outside will cause them to pull out hose and signal line).
4 pulls—Stop pulling hose and signal line.
5 pulls from men outside—Back out.
2-3 pulls—I understand.
3-2 pulls—Repeat signal.
1-3 pulls given from either inside or out—Distress.

These or some other similar simple code will suffice for ordinary work.

Always leave at least one man with a helmet outside who will take and give signals, watch outside conditions, report same to crew operating in the building, and also act in an emergency which requires a helmet, such as accident to men inside, etc.

Each helmet is equipped with a telephone receiver and transmitter, and there is carried as part of the outfit a reel of 400 feet of telephone cable, also a set of dry-cell batteries and a receiving and transmitting outfit to be used by the man or officer in charge of the fire on the street; but the rope signal has proved so efficient that it has been rarely necessary to resort to the telephone equipment of the helmets. It would take

something like three minutes to connect it up, and that would be too much time to lose.

In quite a few cases the Rescue Company has done remarkable work by the use of these helmets by entering the holds of vessels which were heavily charged with smoke and fumes and doing good execution with a 2½-inch line, and in many cases extinguishing the fire.

A case I have in mind which will show you the value of this piece of apparatus happened a few months ago on a steamship moored to a pier in the East River.

A still alarm came in for this ship, and upon the arrival of the company the captain was notified that a man had entered the hold of the vessel and had been overcome by the fumes of the chemicals used in fumigating ships, which consist of a mixture of water, muriatic acid and cyanide of potassium. The water and acid are placed in a tub and the cyanide of potassium is placed in a small bag and hung over the tub by a cord leading from the upper deck to the lower hold of the vessel; all openings leading into the hold are closed, then the cord is cut, dropping the bag of cyanide of potassium into the water and acid; everything is then battened down tight for several hours; at the expiration of this time the hatch covers are removed and the hold allowed to ventilate for at least seven hours before allowing any one to enter.

The officer in charge of the firemen was told by the fumigating officer that the period of ventilation was not up, and that it meant instant death for any man entering the hold of the vessel. The fire department officer immediately sent in a special call for the Rescue Company, and upon its arrival the men donned the smoke helmets and descended into the hold; they placed a rope around the man's body and he was hoisted to the deck, but was found to be dead.

The helmets were removed from the men that entered the hold and they showed no signs or ill effects of the deadly fumes, which to my mind shows the value of the apparatus.

Oxygen Cutting Torch.

This burner or torch is one of the most valuable tools used in the Marine Division; it is used for cutting holes in the steel decks and bulkheads of vessels; without it in a great many cases it would have been an impossibility to check the spread of fire. It is very often necessary to cut holes in the deck plates and bulkheads of ships, especially where red heat shows and you are unable to send men into the hold to direct streams between the cargo and deck plates owing to the intense smoke and heat and the cargo being stowed up close to the deck plates. By cutting a hole in the deck plates and dropping down your distributors or cellar pipes, you can readily understand the result.

A peculiar thing about cutting devices operated by gas under pressure is that they will not cut cast iron; the theory of this is that cast metal is too porous and the molecules or constituent particles composing it will not retain the intense heat required to fuse the metal.

Hook Ladders.

Hook ladders are a special tool used for the convenience of the firemen. The ordinary ladder placed against the side of a ship with the

butt on the deck of the fireboat would be liable to fall and injure someone if it were not constantly attended to, owing to the motion of the fireboat, which at times is heavy—in a great many cases caused by the traffic in the river.

These hook ladders are nothing more than the regular beam ladder with a 14-inch hook on the head of each beam.

They are hooked on the rail of the vessel with the butt hanging down clear of the deck of the fireboat, and no matter how the fireboat may roll in a sea-way, it will have no effect on the ladder.

They can also be used to good advantage entering the holds of vessels, especially where a good foundation for the butt is not obtainable; by lowering the ladder down the hold and placing the hooks over the hatch coamings you are sure your ladder is secure.

Tower Pipes.

The tower pipe on a fireboat is a 4-inch standpipe line constructed inside the lattice work of a military mast; at the head of this mast a platform is constructed, surrounded by a guard rail for the use and protection of the man operating the pipe; it is equipped with a controlling valve and a 2-inch nozzle, and is connected directly with the pumps; the pipe rises to a height of 26 feet from the deck of the fireboat.

Streams from the tower pipe are very effective at fires on double-decked pipers, ships with high free boards, lighters having big deck loads, floating grain elevators, coal hoists and other craft having high free board; they are also used at warehouse fires along the river front, and act in the same capacity as a water tower, driving streams in on the upper floors of the building.

In crowded slips this pipe has an extensive range in all directions. It is of tremendous value when fires have full possession of the superstructure and decks of ships, in which case the stream from the tower pipe will drive back the fire and enable the members of the company to gain a foothold on the decks of the burning vessel with hand lines.

Rail Pipes.

This is a special tool used on fireboats with great effect; it consists of a short metal pipe casting with a male coupling on one end and a female coupling on the other; it has a stem or shank fastened by a band to the middle of the pipe which operates on a hinge or swivel; the stem is fitted with a key and slot; when the rail pipe is used in operations at fires, it is placed in position in sleeve on top rail of fireboat; lines of hose are stretched from the outlets of the turrets to the female connection on the rail pipe and a nozzle of proper size is connected to the male end; it can be set at any desired angle, and will remain in position at which it is set without further attention; thus one man can operate a number of streams from rail pipes; the direction of the stream can readily be changed by one man no matter what pressure is on the line.

Streams from rail pipes can be used very effectively on fires under piers, on docks and where débris, oil or merchandise is on fire and floating in the tide water; the rail pipe is of the greatest service also for cooling the sides of burning vessels and preventing the heat from igniting other vessels or merchandise in the vicinity.

Three-Way Gate Connection.

The three-way 3½-inch to 2½-inch gate connection in service in the Marine Division is in my opinion an indispensable tool for fireboats for the reason that at all fires in ships extra lines are required almost any minute.

One 3½-inch line is stretched from the turret on the fireboat to the deck of the ship and connected to the 3½-inch inlet of the gate connection; three lines of 2½-inch hose are then stretched connecting the female couplings to the 2½-inch outlets. Put on the proper size nozzles and start water on the pumps; each 2½-inch line is then controlled independently by the operation of the valves on this gate connection.

Pipe Holders.

Pipe holders are used in the Marine Division when operating lines of hose on shore, stretched from the fireboats. These tools are very necessary for handling lines of hose under heavy pressure and where powerful streams of water are required. A heavily charged line of hose with suitable size nozzle secured properly with a pipe holder can do the work of several men.

Rivet Cutter or Flogging Chisel.

Rivet cutters or flogging chisels are large cold chisels fitted with long wooden handles; they are very useful in cutting off bolts or the heads of rivets on board vessels.

Spray Nozzle.

(*Pepper Box.*)

This nozzle throws a very fine spray and is useful in wetting down cotton, hay, hemp, jute, flax or other vegetable fibre, also rubbish, etc.

Search Light.

Search light of 700 candle power mounted on top of pilot house will throw a powerful beam of light at night, enabling the pilot of the fireboat to observe all obstructions in slips and docks when entering. It is of great assistance to firemen while fighting fires at night and in fog, when its beam is used for locating piers and street when company is about to make a landing. It is also of great value at night, locating persons who have jumped overboard from burning vessels.

Electric Hand Light.

This light is a very valuable adjunct to the firemen for penetrating into dark holds of vessels containing chemicals from which arise gases which are deadly singly or in combination, and in the event of a lamp being used which has an open flame, it would result in an explosion, in many cases causing loss of life. It is absolutely necessary for firemen's equipment to enable them to enter the holds of oil tank steamships.

3½-Inch to 3-Inch Double Female Connection.

This tool or appliance is a double swivel connection, 3½ inches on one end and 3 inches on the other; it is used when connecting a line of 3½-inch hose from a fireboat to a high pressure hydrant.

The 3½-inch line is connected to the turret of the fireboat and stretched to the high pressure hydrant; a pressure gauge is then connected to the hydrant; this leaves a male end on the hose and a male end on the pressure gauge; the two male ends are then connected together by the use of the 3½-inch to 3-inch double female connection.

In addition to the special tools mentioned, a complete set of various size nozzles, increasers and reducers and various other tools carried by Engine and Hook and Ladder Companies are carried on fireboats.

The Bureau of Fire Prevention in Chicago.

We sometimes wonder whether the author of the old saw about an ounce of prevention being worth a pound of cure really meant to suggest an antagonism between the two ideas. Whatever his intention, he certainly succeeded in indoctrinating the bulk of mankind pretty thoroughly with the notion that such an antagonism exists, and it is only in our own generation that physicians have begun to regard preventive medicine with favor, that here and there a philanthropist has extended his interest from the symptoms to the causes of destitution and feeble-mindedness, and that the Bureau of Fire Prevention has come to be regarded as a vitally important department of the fire service.

Even today a Bureau of Fire Prevention working in close co-operation with the fire-fighting forces of a great city is the exception rather than the rule, and there is consequently still plenty of instructive interest in studying the organization of such a Bureau where it has proved itself eminently successful. The Chicago Bureau, over which John C. McDonnell (Member N. F. P. A.) presides as Chief, is a case in point, and the particulars here given of its methods should be full of suggestion to the responsible authorities in other cities.

It is provided by ordinance that the Chief of the Bureau shall be one of the Assistant Fire Marshals of the City Fire Department, and shall be selected for his office by the City Fire Marshal. The powers and duties of the Chief are very wide, as will be seen from the following quotation from the ordinance:—

> The Chief of Fire Prevention and Public Safety shall have the power and it shall be his duty to enforce the provisions of all ordinances of the City of Chicago which may tend to prevent the starting or spreading of fires or disastrous results in case of fires.

In addition to the necessary clerical staff and the inspectors (of whom more will be said in a moment), a special class of officers known as fire prevention engineers are assigned to the Bureau. Chief McDonnell is particularly enthusiastic over the good results flowing from the association between these engineers and the practical firemen. The Fire Prevention Engineer in Charge acts as Deputy Chief of the Bureau, and must be either a fire prevention engineer by profession or one who has

had at least five years' practical experience in the work of fire prevention. Similar qualifications are required from the Deputy Fire Prevention Engineer in Charge, to whom the immediate charge of all inspections is assigned by the ordinance. Persons certified to fill appointments as fire prevention engineers of the Bureau are allowed a reduction in practical experience to three years, but must otherwise be qualified as above. These officers participate largely in the inspection work. Appointments in every case are made by the Fire Marshal according to law.

"Fire Prevention Inspectors" are required to be members of the Fire Department in good standing, and the method of their assignment is interesting. Chief McDonnell says:—

"The firemen are assigned to the Bureau under a system. The thirty-five firemen inspectors of the Bureau are the thirty-five men standing highest on the waiting Civil Service eligible promotional list for Lieutenants in the Fire Department, having been assigned without exception in the order of their standing on said list. As vacancies occur in the Department in the rank of Lieutenant, the men are promoted out of the Bureau in the order in which they are assigned to the Bureau and as they stand on the promotional list. In order to get on the list, of course, these men are required to undergo an examination, including a rather severe physical test. Under this system the personnel of the Bureau as it relates to the firemen inspectors is changing from time to time. Some have, and may again, question the wisdom of changing inspectors. But we like it and see the benefit of it from many angles.

"In the first place, it tends to keep the men of the Department who are ambitious and preparing for Civil Service examinations brushed up on fire prevention subjects, whereas if men were permanently attached to the Bureau the balance of the Department would be very liable to lose interest in prevention features. Again, there is the possibility of those in the Bureau becoming a bit stale and indifferent. But the best reason and the greatest good anticipated from our system, and that which is indeed being realized to a very gratifying extent, is that the system constitutes a schooling and an opportunity for the prospective young officers of the Department, through their association with our fire prevention engineers, otherwise impossible to obtain.

"In less than five years more than one hundred Lieutenants have graduated through this Bureau. We find them already of vast benefit to the Bureau through their understanding of and co-operation with our work."

In this connection considerable interest attaches to the type of questions that are asked candidates for appointment by the Civil Service Commission. Through the courtesy of Chief McDonnell we are able to reproduce below papers that have actually been used in past examinations for Lieutenant of the Fire Department and Fire Prevention Engineer. These will indicate the standards required for the offices mentioned.

Civil Service Commission, City of Chicago.

Examination—Lieutenants (Fire Dept.), Class F, Grade II.

Subject—Duties.

Penmanship to be graded on answer to Question No. 1.

1. What do you understand to be the duties of a lieutenant in quarters, (a) when the captain is present; (b) when the captain is absent; (c) what are the duties of a lieutenant at a fire when the captain is absent?
2. How would you proceed to extinguish a fire in a building used as a crockery store, heavily charged with smoke?

3. (a) What buildings according to the city ordinances must be equipped with a sprinkler system?
   (b) What would you do on your arrival at a fire on the fifth floor of a building equipped with a sprinkler system?
4. What buildings according to the city ordinances must be equipped with an inside standpipe?
   (b) What buildings according to city ordinances must be equipped with fire escapes?
   (c) What are fire escapes used for?
5. What precautions are usually taken to prevent fires and in emergencies to save lives in the following buildings: (a) theatres; (b) department stores; (c) schools?
6. (a) Describe a fully equipped first-class aerial motor truck.
   (b) Name the different motor apparatus used in the Fire Department.
   (c) Describe a first-class Continental steam fire engine.
7. As a lieutenant in command of an engine company which was the first to arrive at a fire, what method would you take to extinguish and what precautions to prevent the spread of fire in the following buildings: (a) grain elevator; (b) cold storage; (c) freight depot?
8. What are the dangers the Fire Department has to contend with that may cause explosions at fires?
9. Assume that your company is late in arriving and getting to work at a fire, make an official report of the same to the Fire Marshal, giving cause for delay. (Do not sign your name.)
10. How should hose be taken care of (a) in quarters; (b) at fires; (c) what precautions would you take in leading out a line of hose up a stairway going to work on the upper floors of an apartment building?

Examination—Lieutenants (Fire Dept.), Class F, Grade II.

Subject—Arithmetic.

Show All Work in Full.

1. Copy and add the following:

27935
5264
3515376
962
1421
23
6784
12917

2. If an auto truck travels 15 miles in 1 hour, what part of a mile will it travel in 3 minutes?
3. A stock of goods valued at $16,450 was damaged by fire and water to the extent of 35% of its value, what was the amount of the damage?
4. A department purchased 3,690 feet of 3-inch hose for $5,904. What was the price per foot?
5. Multiply 329,430 by 24 and divide the result by 15.

Civil Service Commission, City of Chicago.

Examination—Fire Prevention Engineer, Class B, Grade II.

Subject—Special Subject.

1. Define the following:
   (a) Joisted construction.
   (b) Mill construction.
   (c) Pittsburgh or laminated mill construction.
   (d) Plain brick wall.
   (e) Wood sheathed brick wall.
   (f) Plaster furred brick wall.
   (g) Pier and panel wall.
   (h) Pilaster.
   (i) Floating foundation.
   (j) Gridiron (theatre).
2. (a) Distinguish between "balloon frame" and "braced frame" construction.
   (b) Name the principal members of a frame building.
   (c) State three reasons why frame buildings are usually fast-burning.
   (d) In what respects do joisted brick buildings resemble joisted frame buildings structurally?
3. (a) What purpose does a parapet serve?
   (b) What is meant by "coping" and what are its functions?
   (c) What is wired glass?
   (d) Should wired glass skylights be placed over stair or elevator shafts? State reasons.
4. (a) What chemicals are used in ordinary "acid and soda" fire extinguishers?
   (b) Give the chemical reaction.
   (c) State how water is expelled from such extinguishers.
5. Of the portable fire extinguishing devices now on the market, state which is preferable for extinguishing fires in the following places or materials:
   (a) Gasoline fire in a garage.
   (b) Calcium carbide.
   (c) Wires on an electrical switchboard.
   (d) In the ceiling of a joisted building.
6. State how each of the following acts to extinguish fire:
   (a) Steam.
   (b) Water.
   (c) Sand.
   (d) Carbon tetrachloride.
   (e) Carbon dioxide.
7. (a) Define "common hazard."
   (b) Name three types of common hazards.
   (c) Name two "seasonal" hazards.
   (d) State the hazards attendant to the use of gasoline lamps.
8. (a) Define "spontaneous ignition."
   (b) State which of the following are subject to spontaneous ignition:
      1. Oily waste.
      2. Baled green hay.
      3. Gasoline.
      4. Linseed oil on cotton cloth.
      5. Lamp black.
      6. Sawdust and oil.

7. Crude oil.
8. Castor oil.
9. Lard oil (rancid).
10. Ammonia.

9. What are the ordinance requirements relating to the construction, ventilation and maintenance of motion picture machine booths?

10. (a) How should steam pipes be arranged with respect to inflammable material?
(b) State how wood may be ignited by a steam pipe.

Subject—Report.

A 5-story standard mill construction building has an area of 60 feet by 160 feet; beams are 6 by 12 inches, 4 feet on center, stirruped to girders; bays are 15 feet wide, running the long way of building; occupied as a wholesale grocery; located in the loop, Chicago. Submit specifications for a standard sprinkler equipment.

Examination—Fire Prevention Engineer, Class B, Grade II.

Subject—Experience.

NOTE: Answers to questions on experience will be verified by the Civil Service Commission. Any false statement will be cause for removal from the eligible list or for discharge after appointment.

1. How old are you?

2. Have you had a grammar or common school training or its equivalent? Have you had a high school training? If you have had, give the length of time of that training and state whether or not you were graduated.
Have you attended college? If you have, give the number of years of your attendance, the name of the college and the degree you received, if any.
Have you attended a technical school? If so, give the name and location of the institution and the length of time of your attendance.
Have you had any special training as a chemical, electrical, mechanical or civil engineer? If so, state the nature of that training, where it was received and the length of time it was continued.
Have you done any post-graduate work, research work, or have you pursued any course of study which the above questions do not cover and which would tend to fit you for the position which you seek? If you have, outline the course of that study or research work, and state the length of time it was pursued.

3. (a) Have you ever been employed as inspector for a Board of Underwriters or had practical experience as insurance inspector? If so, give the names and addresses of your employers and state the length of time you were employed by them.
(b) Have you had experience as building superintendent or architect superintendent? If so, give the names and addresses of your employers and the length of time of such employment.
(c) Have you had experience as company inspector or as fire prevention engineer for an insurance company or corporation? If so, give the names and addresses of your employers and the length of time you were so employed.
(d) Have you had any other experience tending to qualify you for the position of fire prevention engineer and which the above questions do not cover? If so, give in detail the nature of the work, the length of time it was continued and the names and addresses of the firms by whom you were employed.

Examination—Fire Prevention Engineer, Class B, Grade II.

Subject—Mathematics.

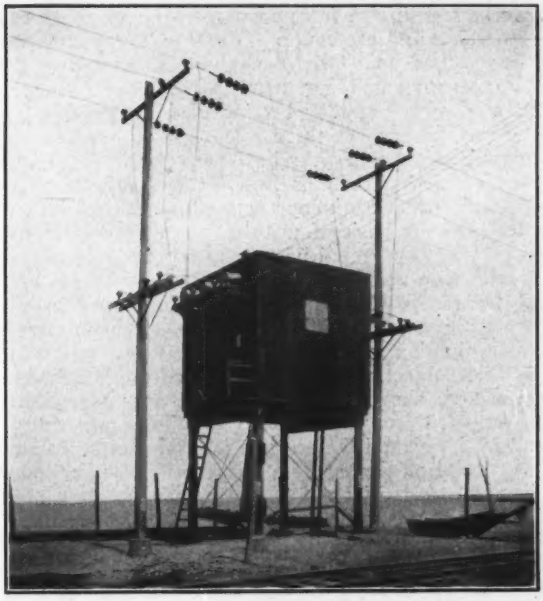
Show All Work in Full.
Use of Slide Rule Permitted. No Books Allowed.

Answer any 6 and no more of the following problems:

1. A horizontal cast-iron pipe of 20-inch internal diameter is to be designed to carry water under a head of 510 feet, using a working stress of 4,500 pounds per square inch. What is the necessary thickness of the pipe?
2. A duplex steam pump 10 x 8 x 12 inches has a piston speed of 720 inches per minute. What is its capacity in gallons per hour?
3. A man travels 108 miles, and finds that he could have made the journey in four and a half hours less had he traveled two miles an hour faster. At what rate did he travel?
4. A rectangular reservoir is 350 feet by 500 feet in size on the bottom and has interior side slopes of 1½ horizontal to 1 vertical, water is 15 feet deep. How many gallons does it contain, there being 231 cubic inches per gallon? (Use prismoidal formula:

$$\text{Volume} = L \frac{(A + a + 4M)}{\left(\frac{\quad}{b}\right)}$$

5. A scow 15 feet wide is 20 feet long at the bottom and 30 feet long at the top and 5 feet deep (outside measurements). If the scow weighs 15 tons, what load in pounds will sink it to a depth of 4 feet?
6. Find the area of the triangle, the co-ordinates of vertices being 3; 3; 2, —5 and —4, —6.
7. Find the area of the circle inscribed in a parallelogram of sides of equal length of 4 feet and the acute angles of which are 60°.



Unnecessarily enclosed installation of lighting arresters on a high voltage line.

Housing of Outdoor Electrical Apparatus.

Life and Fire Hazards, Unreliability and Short Life Make Corrugated-Iron Structures Objectionable.

By Roger L. Evans

Courtesy of Electrical Review.

War-time economies, experience and financial considerations are proving conclusively that it is unwise to spend money when unnecessary. One instance in which needless expenditure is sometimes made is when electrical apparatus is installed outdoors in a housing where a housing is not really necessary. All housings cannot be dispensed with, of course. But many exist that have no justification. The money spent on them and the labor and materials necessary are therefore wasted.

The accompanying illustration shows an outdoor installation, outdoor but enclosed, of lightning arresters on a high-voltage line. The electrical equipment is placed within a wooden structure which is in turn covered with galvanized or corrugated-iron sheets. The sheets are fixed to the wood beams with nails. This class of installation is in wide

favor and can be seen in use from coast to coast for all classes of transformation, switching and protection. Many of the installations are old-timers that have stood up. Others are built because they are standard practice with companies building them.

This class of structure may be criticized for several reasons. To begin with, in many instances there is no need to enclose apparatus, if outdoor equipment is chosen. And then on the basis of initial cost it will often be found that there is little to choose between the outdoor installation and the one with indoor apparatus enclosed in a corrugated-iron structure. On the basis of upkeep the outdoor installation has all in its favor, because corrugated iron corrodes quite rapidly unless properly painted and the wood is protected from rot, whereas a steel frame, properly galvanized, has long life, high salvage, may be moved from place to place without deterioration, and plays an important part should the matter of evaluation ever come up.

But the chief objection to the corrugated-iron structure, of which only a type is here shown, is based on the grounds of life and fire hazards. Corrugated iron nailed to a wooden supporting frame will usually result in fire should the corrugated iron become grounded. Arcs readily set the wood on fire, as does also the flow of current from sheet to sheet. The corrugated-iron sheets may easily become charged, from any one of several causes, with voltage of from a few hundred to several thousand volts, according to the operating voltages of the lines. Such a charged frame constitutes a serious hazard to workmen working in it or entering it where above ground. Pedestrians as well as workmen will also be endangered when these housings are erected on the ground.

The matter of life hazard is entirely one of grounding. But the matter of grounding is not an easy one. It is not easy to efficiently ground each individual corrugated sheet. And it is even more difficult to maintain such mechanical and electrical contact between sheets. The fire hazard is largely one of grounding also, although not entirely so, because the wooden framework must always constitute a combustible material which may be attacked by arcs.

The writer has known some half-dozen instances where transformer, lightning arrester and switching houses constructed of corrugated iron and wood have burnt down because of grounds, arcs from conductors to iron, and so on. He can also cite three instances for which he can vouch where men have been electrocuted by contact with the charged corrugated-iron sheets of these structures.

The inherent objections to the corrugated-iron housing are that the presence of individual sheets makes it expensive and difficult to rigidly ground and maintain grounded each sheet because of the form of construction employed and because of corrosion that invariably occurs; that the supporting frame is of combustible material; that the structure is metallic and covers relatively large space. It would seem that the corrugated-iron housing for electrical apparatus should be boycotted, on the basis of fire and life hazards, on basis of life and cost, and because its life is at best as uncertain as its performance, even if it permits indoor equipment to be placed outdoors on short notice.

Maintenance of Sprinkler Equipments during Cold Weather in Western Canada.

By John Young

(Member N. F. P. A.)

Chief Inspector, Sprinklered Risk Department, Western Canada Fire Underwriters' Association.

The climatic conditions in Western Canada and the western part of Ontario are such that it has been a source of wonder to many how the sprinkler equipments are maintained in a climate where the average temperature is below zero for several weeks at a time. The monthly record of the Meteorological Service of Canada gives the following temperatures for the month of January, 1918:

	Maximum Temperature	Minimum Temperature	Mean Maximum	Mean Minimum
Winnipeg	22 degrees	—37 degrees	2 degrees	—12 degrees
Prince Albert ..	40 degrees	—46 degrees	4 degrees	—16 degrees
Moose Jaw	44 degrees	—36 degrees	8 degrees	—10 degrees
Calgary	54 degrees	—24 degrees	24 degrees	— 2 degrees
Edmonton	44 degrees	—43 degrees	15 degrees	— 4 degrees
Le Pas	22 degrees	—43 degrees	— 2 degrees	—17 degrees

We might add that the coldest day in the history of Winnipeg was on December 24th, 1875, when the temperature was recorded as —58.5 degrees. It is also interesting to note that when the temperatures were low the velocity of the wind was very slight, almost complete calms prevailing in some instances.

In a climate where the temperature is as low as that recorded above, more attention is paid to the construction of buildings so as to keep them warm. For instance, nearly all buildings are provided with storm sash. Architects base their calculations on a minimum temperature of —40 degrees instead of zero, or slightly less, as would be the custom in warmer climates.

In Western Canada it is customary to lay water mains at a depth of 7 feet to 11 feet, according to the soil and location. During the unusually severe winter of 1915-16, city water mains were found frozen at a depth of 6 feet, and underground mains supplying sprinkler systems were found frozen at a depth of over 9 feet. With this experience, care is taken to see that all water mains are laid to a satisfactory depth.

As might be expected, a large percentage of sprinkler equipments are on a dry-pipe system, as it has been found that an open window or a coal chute left open while taking coal would be sufficient to freeze parts of a sprinkler system.

In this territory only about 25 per cent. of the plants have gravity tanks as a second supply for the sprinkler system; the remainder have either pressure tanks, steam pumps, or city water only. It has been

found advisable to use either steam pumps or pressure tanks instead of gravity tanks owing to the difficulty and cost of keeping gravity tanks in working order. Several gravity tanks have been changed to pressure tanks.

The several methods of heating gravity tanks are as follows:

(a) Direct steam line into the tank.
(b) A steam coil in the tank.
(c) An individual coal-fired heater at some suitable location either in the building or in pit at base of riser.
(d) One of the types of heater installed by the sprinkler companies.
(e) A coil or pipe or similar contrivance placed underneath the boiler and maintaining a circulation similar to that of a tank heater.
(f) Installing the tank in a heated tower over the elevator shaft.

The above have each their respective merits, but the following observations may be of interest:

(a) This is used but little, as in this territory constant heat is required, and this is suitable when heat is required only at times.
(b) This sometimes stops circulating when the steam pressure is low and the tank is liable to freeze.
(c) This has given good satisfaction where of satisfactory size, and is recommended where it is not practicable to use other types of heaters.
(d) The tank heaters have been fairly satisfactory where sufficient steam pressure has been maintained and heaters of ample size have been used. The heating capacity must be at least 50% greater than that used in the south and east.
(e) This has been found to be one of the most satisfactory methods of heating where steam pressures have not been maintained.
(f) This has been found to be an economical way of keeping the tank warm but involves a rather high first cost.

Our experience has been that it is not satisfactory to use any means of heating except where there is a circulation through the full length of the riser. Several of the above-mentioned means of heating the tanks are suitable for this purpose, but their capacity must be greater than is generally used. Heaters should be cleaned out occasionally, as deposits inside the heater have caused trouble at times.

We had during the winter of 1916 a very severe spell of cold weather in Alberta, and as a result considerable difficulty was experienced in keeping automatic sprinkler systems in working order. It was necessary to shut off one sprinkler system for several days. As there was a dry valve in this plant, the portions liable to freeze were put on the dry-pipe valve, and no further trouble has been experienced. In another in this territory the underground mains, buried 9-10 feet under cover, were found to be frozen. An electric thawing machine was used to thaw out the pipes. Thereafter daily tests were made by opening the test pipe under the dry valve and noting if the drop in pressure was lower than the day before. The water being drawn through the piping evidently helped to melt the ice, and in this way the sprinkler system was maintained. We might state that the weather conditions prevailing in Alberta during the winter of 1915-16 were equalled only during one other winter in the history of the country.

In Winnipeg, where we have the majority of our sprinklered properties under the supervisory service, the following methods are used. A supply of plugs up to 1½ inch, extra sprinklers and wrenches are kept at a central station, and similar apparatus is kept at the Underwriters' Office. In case of a small piece of pipe bursting, the damaged piping is taken out and the opening plugged, thus leaving as small an amount out of commission as possible. In the case of a head opening, the head is replaced and the system placed in commission. A telephone is placed in the Inspector's residence, and the Supervisory Central Station notifies him. In the event of serious trouble, the Inspector can then go directly to the plant affected. This has been found to be advantageous in several instances.

As a whole, we passed through the winter of 1917-18 with comparatively a small amount of trouble, the main troubles being three tanks badly frozen and a few slight "freeze-ups" which were remedied without delay.

Protection of Water Mains, Fire Hydrants and Valves in Winnipeg.

By Thomas H. Hooper

Operating Superintendent of Waterworks.

Fire hydrants in the City of Winnipeg are installed for fire-fighting purposes only, to be used by the fire brigade in fighting fires. The climatic conditions are very severe, the cold in winter sometimes dropping to 40 or 45 degrees below zero. It is during this season that the work of this particular branch becomes heavy. The fact that the firemen of this city have never found a hydrant out of commission when required, through being frozen or from other causes, has been brought about, firstly, by a system of daily inspection in the downtown portions and congested areas, tri-weekly in the adjoining districts, and bi-weekly in the outer portions of city.

All hydrants immediately after use in winter seasons are repacked with a composition of tallow and hemp packing placed in the stuffing box in hydrant head; otherwise the operating nut would be frozen solid and the hydrant placed out of commission. Occasionally through a faulty drip the water will rise in the post, when a steam boiler is used for the purpose of forcing steam into post to thaw same out.

When a hydrant is found out of repair, the Fire Brigade is notified at once, and when placed in commission the Brigade is informed. All repairs to hydrants are treated as emergency jobs, and workmen stay until repairs are completed.

Hydrant repairs are divided into two classes, light and heavy. Light repairs consist of re-packing, renewing bolts or nuts, renewal of parts which can be made without digging out the hydrant. Heavy repairs are occasioned through foreign matter being drawn into hydrant,

such as sticks or stones which have been left in mains at time of construction or the breaking of post or valve.

It is most essential that in laying water mains it should be the duty of some man to inspect each pipe as it is laid, and at night when men lay off work to block the end securely to prevent children from throwing stones in the pipes.

Hydrants are placed at approximately 300-foot intervals on all new mains laid, the waterworks receiving an income from the city at large of $30.00 per hydrant per annum to offset the water consumed and the maintenance of the hydrants.

Considerable trouble was experienced in past years owing to unauthorized persons operating hydrants, using at times alligator wrenches or large monkey wrenches, and in doing so stripping the edge off the operating nut, which is pentagonal in shape. The writer was successful in having a by-law passed making it a crime for any one (except the Fire Brigade) to use a hydrant without first securing the permission of this department.

There are in use in this city at this time 2,360 hydrants and 4,005 valves on domestic service. Valves are inspected the same as hydrants, as it is necessary in case of a break during a fire to localize the break by shutting off the least possible length of main.

Valve repairs are far more frequent than hydrants, caused generally from broken bolts, broken spindles or foreign matter such as sand, stones or sticks blocking valve so as to prevent it being properly closed when required.

The Fire Service Waterworks System or High Pressure which is supplied with water from the Red River receives the same close attention as the domestic system, there being 158 hydrants and 298 valves.

Water Mains.

Water mains in this city are laid at an average depth of 7 feet 6 inches, and in spite of the intense cold, frozen mains are almost unknown. Last year a main in an outlying district was found to be so nearly frozen that only a small stream could be secured at the hydrant. The hydrant was left open, when the water gradually cut the ice away and in time freed itself.

The only other case the writer remembers was where a 10-inch main was frozen solid. To free this main, it was necessary to make four excavations at a distance of forty feet apart; the main was then tapped with 1-inch holes and thawed out with steam from hose inserted in the holes.

If water mains were laid properly in the first place there would be very few repairs required except in the case of electrolysis.

The writer had occasion recently to cut out some sections of cast-iron water main which had been in service for the past thirty-four years, when it was found that the pipe and asphaltic covering was in just as good condition as when laid, there being not the slightest trace of wear. Therefore, if joints were properly made and pipe sufficiently tested prior to laying, there would be very little interruption in the distribution system, guaranteeing a full supply when called on in case of fire.

Kerosene Oil Burners.

Numerous inquiries have lately been received by Underwriters' Laboratories as to the hazard involved in the installation and use of kerosene oil burners in cooking and heating stoves and also in furnaces and boilers for heating plants. The shortage of coal has naturally stimulated the development and sale of such burners, and a number of these appliances have recently been submitted to the Laboratories for approval. It is probable that, as the result of further co-operation from the manufacturers, some of the devices may be approved in the near future. It is well, however, to bear in mind that in the standard regulations of the National Board of Fire Underwriters governing installation of oil-burning equipments the use of oil as fuel for domestic purposes is regarded as more hazardous than the use of ordinary fuel, such as wood, coal and coke.

Generally speaking, the essential parts of an oil-burning equipment consist of a burner or vaporizer which is mounted within the stove or furnace; a fuel storage receptacle; piping to convey the fuel from the storage receptacle to the burner; control valves and some arrangement for collecting excess fuel which may be fed into the burner. Many different types of equipment have been presented for consideration, and in the majority of them provision is made for the storage of the main supply of oil in an underground storage tank. Hand and motor pumps, as also suction by steam, are variously used to deliver the oil from the underground tank to a tank (usually of five gallons capacity) located within the building and near the heating plant. This auxiliary reservoir is equipped at the five-gallon level with an overflow pipe which leads back to the underground storage tank. From this point the designs begin to present more important points of difference, some of which are indicated in the following brief notes upon several types:—

(1) From the auxiliary tank the oil or fuel is fed to the burner by gravity. This burner is equipped with an overflow line which leads to a one-quart receptacle, mounted on a valve in the delivery line. This quart receptacle is placed in a conspicuous position and is mounted on a counterweighted lever attached to the shut-off valve so that when a certain quantity of the fuel is collected in it the valve is thrown to its closed position, due to the weight of the liquid in the receptacle.

(2) The fuel in this type is delivered by gravity from the auxiliary tank to a float-actuated carburetor. A motor-operated blower is used to atomize the kerosene which is drawn from the carburetor on the injector principle. The carburetor and fire-pot are both equipped with overflow pipes which terminate in a one-quart receptacle mounted on a lever connected to a switch and to a shut-off valve in the oil de-

livery line. When sufficient fuel overflows into the one-quart receptacle to throw the lever, the shut-off valve in the delivery line closes and a switch is simultaneously opened which stops the motor. This equipment is provided with a thermostatic control which controls the burning period and also increases the length of the pilot burner within the burner box during the starting interval, so as to ensure ignition of the kerosene vapors.

(3) A third type, similar in many respects to that described in the preceding paragraph, is provided with a reciprocating pump driven by a motor for pumping the oil through an atomizing chamber directly from the underground storage tank, thus eliminating the auxiliary supply tank and the gravity feed.

(4) An equipment designed principally for the burning of fuel oil of the heavier grade is provided with an independent steam coil adjacent to the burner, and the steam generator is used both to atomize the fuel and to draw it up from an underground storage tank by suction.

The equipments thus described are used principally in connection with furnaces, but there are also many devices intended for use in connection with cook stoves. In the greater number of these devices the kerosene is vaporized in a preheating coil and the vapor is delivered to the burner through a small orifice.

It may be of interest to note that one of the features particularly to be tested in these burners is whether or not they can continue to consume the full amount of fuel which will be fed by their valves, and whether or not they are subject to frequent clogging from carbonization. The best designs would appear to be those in which there are no unduly restricted passages subjected to heat, so that carbonization and consequent clogging and necessity for cleaning are reduced to a minimum.

The overflow receptacle is also important. It should have a capacity of not less than one quart, and should be conspicuously located so that in case the burner is not functioning properly and liquid fuel is escaping, the trouble may be observed without delay.

The N. F. P. A. Committee on Inflammable Liquids has also been giving attention to the hazards of fuel oil installations for heating and cooking in homes, and Chairman Edward A. Barrier expects that recommendations for standard regulations with regard to such installations will be ready very shortly. In view of the advantage which has been taken of the coal shortage to push the sale of undesirable types of equipment, it will be a great boon to the more thoughtful class of householders to have authoritative guidance as to the types of system and appliance which present the smallest hazards.

Experiments on Drip Valve Tests.

By Benjamin Richards
(Member N. F. P. A.)

The tests here reported were made by the Underwriters' Bureau of New England at the laboratories of the General Fire Extinguisher Company, Providence, R. I. Through the kindness of the latter concern, all the necessary apparatus to facilitate the tests was freely provided, and also engineers to help in the work. The thanks of all interested in this work are due to the General Fire Extinguisher Company for their co-operation.

It has long been customary to obtain by hose stream tests on the hydrants approximate information as to the amount of water available for sprinklers in a mill yard. There are now so many sprinklered properties without facilities for testing from hydrants that it has become necessary to obtain the desired information through other means. A test at the drip pipe is the most convenient and practical way to judge the amount of water available at the particular riser tested, and in some respects is an advantage over hydrant tests, as it shows whether the branch pipes are clear between the yard or street mains and the sprinkler systems.

The tests were made to determine the approximate amount of water available from a 2-inch drip pipe and to note the effect on gage readings by varying the location of the gages on the riser. A 6-inch riser with a standard valve and 6-inch English alarm valve were used, and a meter nozzle was attached to the drip pipe to measure the discharge.

Figure 1 shows a view of the apparatus as set up for test.

Figure 2 is a drawing of the apparatus with the several gages numbered to correspond with those in the chart.

Figure 3 shows the pressure curves for the several gage locations. The fine dotted line thereon represents the pressure line for the best gage locations corrected to the level of the drip pipe inlet.

Conclusions.

1. The best location for a gage on the sprinkler riser when testing from the drip valve is somewhere on the main riser about one foot below the drip valve.

This is not near enough to indicate excessive fluctuations, and yet is sufficiently removed to yield substantially correct readings.

Gages below the alarm valve seem to vary more uniformly with the discharge than those above the valve.

2. Readings on gages located on the drip fall so rapidly under a draught of water from the drip that a false impression with regard to the real efficiency of the supply is likely to be obtained.

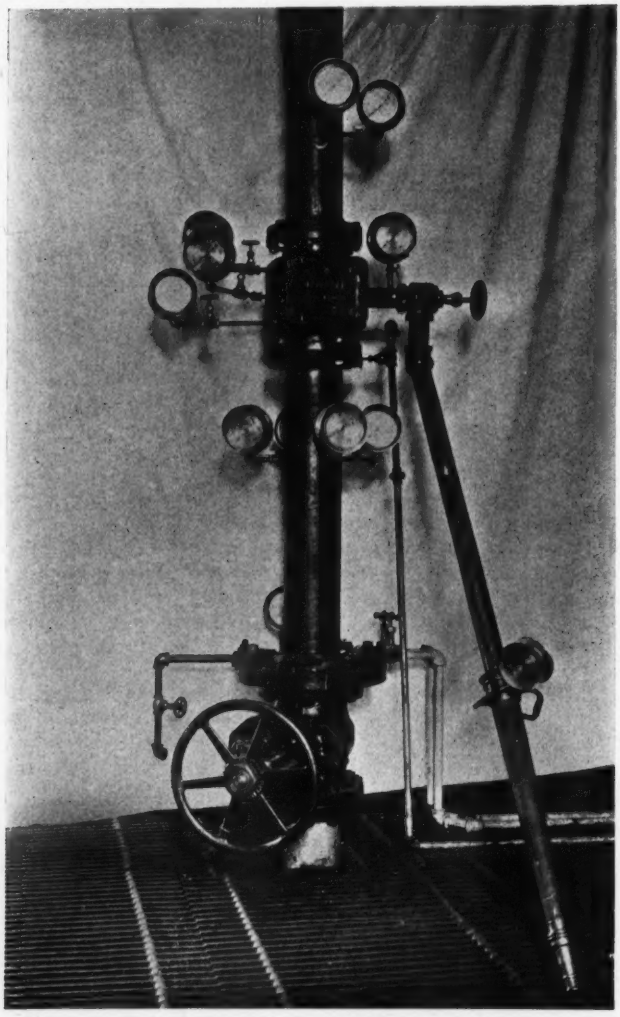


Fig. 1. General view of testing apparatus.

3. Location of gages on alarm valve body is not desirable as compared with location on the main riser.

4. Although the tests described are of most use for the comparison of repeated tests on the same riser, it is evident that with uniformity in the location of gages on the risers the relative efficiency of the supplies available on different systems and at different plants may be compared in a rough way.

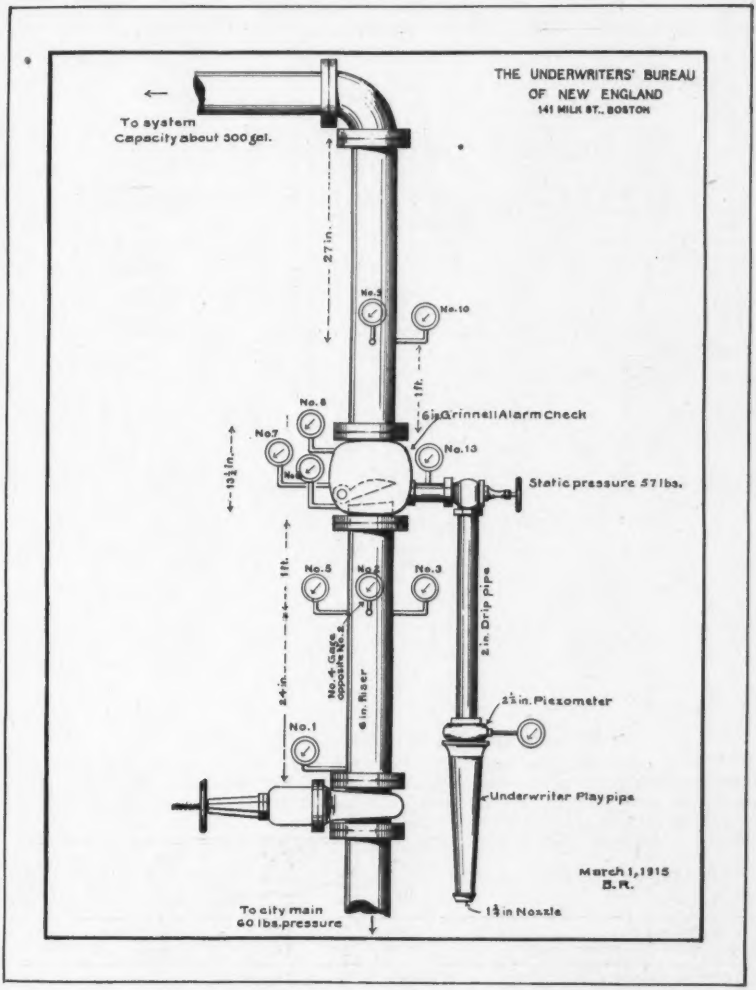


Fig. 2. Drawing of testing apparatus, with gages numbered to correspond with those in the chart on p. 167.

5. For comparison, a record should be kept showing the tests at each riser. A normal fall in pressure with a drip wide open might be 50 lbs. At a winter test a fall of 80 lbs. might be obtained, which would indicate an impairment of the supply, possibly due to ice or other obstruction in the pipes. The records should be kept on tags at each riser or on blanks carried by the inspectors.

LOCATION OF GAGES.

RESULTS	Drip Open (Turns)	Nozzle Size	Nozzle Pressure	Gals. per Min.	Gage Readings: No. 1 Base of Riser	Nos. 2, 3, 4 & 5 1 foot below	No. 7 Opposite drip on Valve	Nos. 9 & 10 1 foot above	No. 13 on Drip
With 1⅛ in. nozzle.	1	1⅛	4.2	77	57	55.5	55	54.5	50
No. 7 gage opposite	1½	1⅛	13	134	57	54	55	54	50
drip did not fall as	2	1⅛	23.6	180	57	53	55	54	49
quantities increased.	2½	1⅛	30	203	56.5	50	53	53	45
Gages 1 ft. below are	Full	1⅛	37	225	56.5	50	52	53	45
best.									
With 1¾ in. nozzle.	1½	1¾	2	132	56	54	55	50	50
Gage 7, opposite drip,	2	1¾	5	208	56	54	54	51	46
drops uniformly.	2½	1¾	8	265	56	51	53	51	42
Evidently 6-in. valve	3½	1¾	12	320	55	51	51	51	37
body and check influ-	Full	1¾	13	335	52	50	50	49	34
ences this.									
With no nozzle on drip.	½	Open	0		57	55	55	55	0
All three gages ap-	1	drip	0		57	55	54	54	0
parently O.K.	1½	(no	0		57	55	54	54	C
No choice.	2	noz-	0		56	52	51	51	0
	2½	zle)	0		55	50	51	52	0
	Full		0		53	49	49	48	0
	6-in. Gate Valve Open (Turns)								
Gate valve at base of	1½	1¾	4	186	20	11	10-11		4
riser opened, different	2	1¾	8.5	270	36	33	33-34	33	22
degrees. Drip pipe	2½	1¾	10	295	45	42	40	39	27
valve wide open.	3	1¾	11.5	315	50	45	45	44	30
No choice of gages.	3½	1¾	12	320	50	47	47-48	47	32
	4½	1¾	13	335	50	50	50	49	34

EFFECT OF OBSTRUCTING THE SUPPLY.

This chart shows the results of obstructing the flow in varying degrees by partially closing the main valve. These comparisons were made with the same amount of water flowing from the drip (so far as possible to obtain) when obstructed and when not obstructed.

STATIC PRESSURE 57 LBS.	Gals. Flowing	No. 1 Gage at Base of Riser	**Nos. 2 & 5 1 foot below alarm**	No. 7 Opposite Drip	Nos. 9 & 10 1 foot above	No. 13 on Drip	Nozzle Pressure
No obstruction	180	57	**53**	55	54	49	23.6
Riser valve 1½ turns open.....	186	20	**11**	10-11	—	4	4
No obstruction	265	56	**51**	53	51	42	8
Riser valve 2 turns open.....	270	36	**33**	33-34	33	22	8.5
No obstruction	320	55	**51**	51	51	37	12
Riser valve 3 turns open.....	315	50	**45**	45	44	30	11.5
Riser valve 3½ turns open.....	320	50	**47**	47.5	47	32	12
No obstruction	335	52	**50**	50	49	34	13
Riser valve 4½ turns open (practically open)	335	50*	**50**	50	49	34	13

* This gage located near the throttled valve, so reads lower than if not throttled.

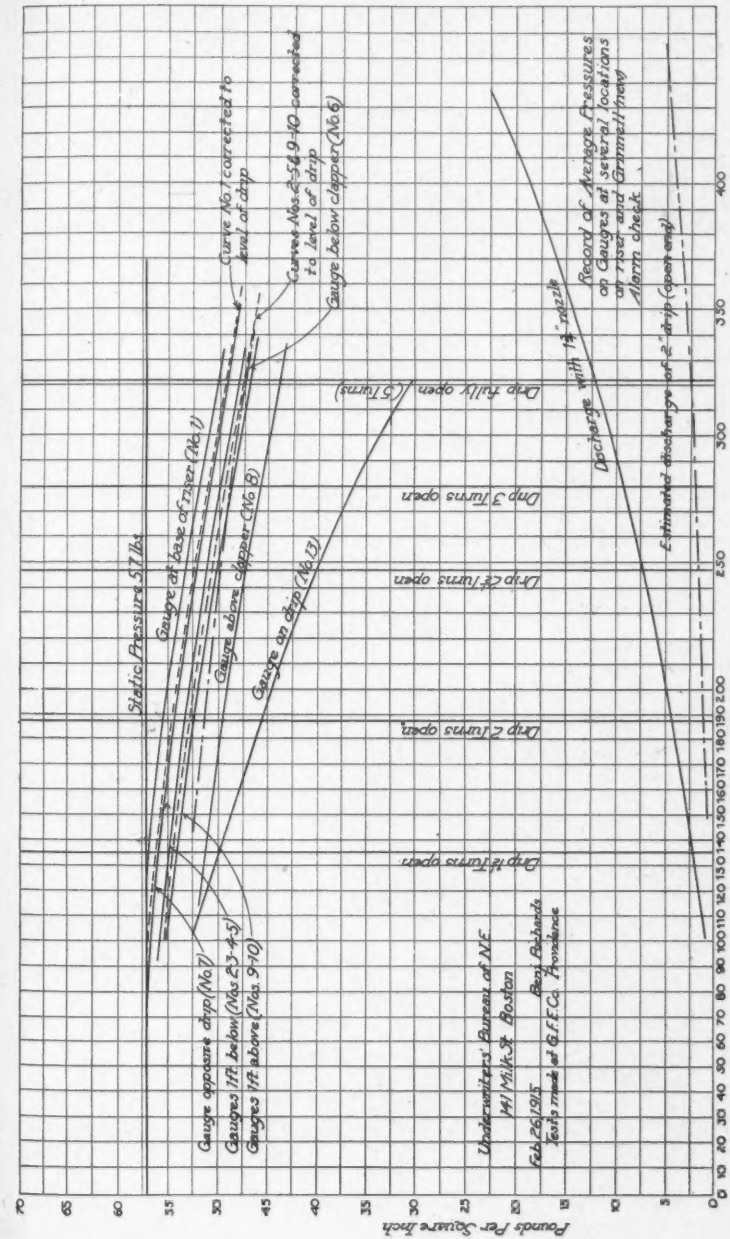

Pounds Per Square Inch
Gallons Per Minute Flowing
Static Pressure 57 lbs.
Gauge at base of riser (No.1)
Curve No.1 corrected to level of drip
Curves Nos. 4-5-8-9-10 corrected to level of drip
Gauge below clapper (No.6)
Gauge above clapper (No.8)
Gauge on drip (No.13)
Drip fully open (5 turns)
Drip 3 turns open
Drip 2½ turns open
Drip 2 turns open
Drip 1½ turns open
Gauge opposite drip (No.7)
Gauges 1ft. below (Nos. 2-3-4)
Gauges 1ft. above (Nos. 9-10)
Underwriters' Bureau of N.E.
141 Milk St. Boston
Feb. 26, 1915
Tests made at G.F.E.Co. Providence
Benj. Richards
Discharge with 1¾" nozzle
Record of Average Pressures on Gauges at several locations on riser and Grinnell new Alarm check
Estimated discharge of a 2" drip (open end)

Fig. 3. Chart showing pressure curves for the several gage locations. Fine dotted line represents pressure line for best locations corrected to level of drip pipe inlet.

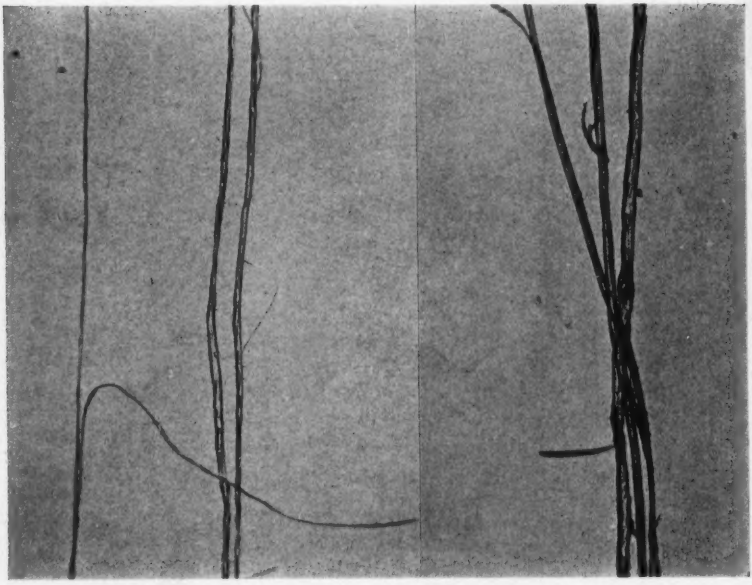


Fig. 1. Linen (on left) and hemp fibers magnified 100 and 110 diameters respectively.

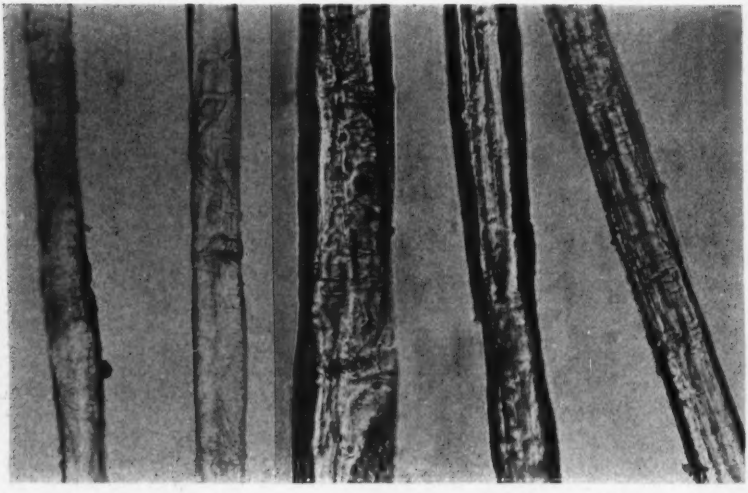


Fig. 2. Linen (on left) and hemp fibers magnified 1200 diameters.

The Substitution of Cotton and Hemp Yarns for Linen Yarns in Unlined Fire Hose.

By H. G. Wilson,

Assistant Secretary Underwriters' Laboratories.
(Member N. F P. A.)

Manufacturers of fire-protective appliances, like those engaged in almost every other industry, are feeling the need of substitutes for materials which were formerly supplied through such well-regulated channels that the possibility of an interruption of the supply was given little, if any, thought. Among the materials the supply of which is now restricted, which were supposed to be necessary in the manufacture of fire protection appliances, linen yarn is included. Statistics compiled by the raw materials section of the British War Office show that Russia produced 80 per cent, France and Belgium 10 per cent, Germany and Austria 6 per cent, Ireland 2 per cent and Holland 2 per cent of the flax required for the manufacture of yarn, from which it will be seen that the recent refusal of Great Britain to export any of this material to this country cuts off the entire supply. The stock at present in possession of Great Britain is being held for essential war purposes, such as the manufacture of fabrics for aeroplanes.

Tests and investigations have recently been conducted at Underwriters' Laboratories to determine to what extent, if at all, cotton and hemp yarn and tow may be substituted for linen yarn in the manufacture of unlined fire hose with a view to increasing the quantity of hose obtainable from such stocks of linen yarn as may be available.

Hydrostatic pressure tests in accordance with the established standards were made on samples of 1½-inch, 2-inch and 2½-inch hose supplied by different manufacturers. An examination of the samples showed that the filler strands were manufactured from cotton yarn and that these strands composed approximately 30 to 40 per cent of the weight of the completed hose, the percentage varying in samples of different manufacture. The test data indicate that, so far as the bursting strength values are concerned, cotton yarn may be substituted for linen yarn for the filler or woof strands of the circular woven construction. Micro-photographs, as shown in the illustrations, were taken of the fibers of yarn for identification purposes.

The leakage tests showed a leakage slightly in excess of that prescribed for best quality linen yarn, but this was not considered to be of enough importance to constitute an objection to the intended use of

the material, the amount of leakage not being sufficient to cause undue loss in the working pressure of a fire hose stream.

Careful examination of fabrics built up of cotton filler threads and linen yarn warp threads disclosed no ground for believing that water friction losses will materially differ from those regularly obtained with unlined linen hose.

Subsequent to the above-mentioned investigations, samples composed of various percentages of cotton, ranging from 54 to 100 per cent of the total weight of the hose, were tested, and the conclusion was reached that owing to excessive leakage certain constructions could not be considered as acceptable substitutes for unlined linen fire hose. The following are the constructions which were deemed unacceptable on the ground that working pressures would be seriously reduced by leakage if they were used:—

(1) A construction employing 100 per cent cotton yarn substituted for linen yarn.

(2) A construction employing any percentage of mixture of cotton or linen yarn in the twisted strands for warp or woof members.

(3) A construction employing cotton yarn for the warp members.

Hydrostatic tests have also been made on unlined hose made exclusively of hemp yarn, and it appears from the investigations so far made on hose of this character that if hemp yarn in necessary quantities and of suitable quality can be secured from spinners, without drawing upon supplies of this material necessary for other essential uses, it may be possible to accept, for the period of the present emergency at least, unlined hose made of hemp yarn in lieu of the unlined linen hose previously specified for use at standpipes and elsewhere in buildings.

The test data from which the foregoing conclusions have been drawn will be found in tabular form on pages 171 and 172.

Description of Sample	Size of Hose	Mfr.	Samp. No.	POSITION Straight	POSITION Curved	POSITION Kinked	O. K. or Failed	REMARKS
Cotton Fillers Linen Warp Approx. 40% Cotton	2½"	A	1	325			35% Low	Ruptured along crease. Filler yarn.
			2	325			35% "	" " "
			3		325		35% "	" " "
			4			300	O. K.	Ruptured at kink. Warp yarn.
		B	1	475			5% Low	Ruptured along crease. Filler yarn.
			2		475		5% "	" " " " "
			3			425	O. K.	" " " " "
	2"	A	1	375			25% Low	Ruptured along crease. Filler yarn.
			2	375			25% "	" " " " "
			3		375		25% "	" " " " "
			4			375	O. K.	" " " " "
		B	1	575			O. K.	Ruptured along crease. Filler yarn.
			2		575		"	" " " " "
			3			425	"	Ruptured at kink. Warp yarn.
	1½"	A	1	575			O. K.	Ruptured along crease. Filler.
			2		600		"	" " "
			3			500	"	Ruptured at kink. Warp yarn.
		B	1	650			O. K.	Ruptured along crease. Filler yarn.
			2		625		"	" " " " "
			3			525	"	Ruptured at kink. Warp yarn.
Cotton Warps. Linen Fillers. Approx. 54% Cotton.	2½" 2" 1½"	B	No bursting results obtained. Insufficient pressure due to excessive leakage.					
Cotton Warps. Cotton Fillers. (100% Cotton)	2½"	A	No bursting results obtained. Insufficient pressure due to excessive leakage.					
Hemp Warps. Hemp Fillers.	2½"	A	No bursting results obtained. Insufficient pressure due to excessive leakage.					
Tow Warps. Tow Fillers.	2½"	A	No bursting results obtained. Insufficient pressure due to excessive leakage.					
Tow Warps. Tow Fillers.	2½"	A-1	No bursting results obtained. Insufficient pressure due to excessive leakage.					
Tow Warps. Tow Fillers.	2½"	A-2		375	375			Ruptured along crease. Filler yarn.

DATA SHEET FOR LEAKAGE TESTS—SECOND WETTING.

June, 1918.

Description of Sample	Size of Hose	Mfr.	Leakage per Linear Foot Gallons per Minute		O. K. or FAILED		DESCRIPTION OF WEAVE
			1st Min.	2nd 5 Min.	1st Min.	2nd 5 Min.	
Cotton Fillers. Linen Warp. Approx. 40% Cotton.	2½″	A	0.057	0.025	O. K.	150% High	15 cord filler—13 picks per inch. 68 ends of warp per inch. (double strand) 3 cord warp yarn.
		B	0.049	0.021	O. K.	110% High	25 cord filler—13 picks per inch. 64 ends of warp per inch. (double strand) 3 cord warp yarn.
	2″	A	0.042	0.028	O. K.	250% High	15 cord filler—14 picks per inch. 68 ends of warp per inch. (double strand) 3 cord warp yarn.
		B	0.044	0.036	O. K.	400% High	25 cord filler—13 picks per inch. 64 ends of warp per inch. (double strand) 3 cord warp yarn.
	1½″	A	0.040	0.025	O. K.	315% High	15 cord filler—14 picks per inch. 68 ends of warp per inch. (double strand) 3 cord warp yarn.
		B	0.041	0.025	O. K.	315% High	25 cord filler—13 picks per inch. 64 ends of warp per inch. (double strand) 3 cord warp yarn.
Cotton Warps. Linen Fillers. Approx. 54% Cotton.	2½″	B	No measurements taken. Leakage noted to be excessive by observation.				15 cord filler—13½ picks per inch. 66 ends of warp per inch. (double strand) 5 cord warp yarn.
	2″						15 cord filler—13½ picks per inch. 66 ends of warp per inch. (double strand) 5 cord warp yarn.
	1½″						15 cord filler—13 picks per inch. 66 ends of warp per inch. (double strand) 5 cord warp yarn.
Cotton Warps. Cotton Fillers. 100% Cotton.	2½″	A	0.120	0.305	O. K.	2950% High	15 cord filler—14 picks per inch. 66 ends of warp per inch. (double strand) 4 cord warp yarn.
Hemp Warps. Hemp Fillers.	2½″	A	0.123	0.198	O. K.	1880% High	9 cord filler—13½ picks per inch. 66 ends of warp per inch. (double strands) 2 cord warp yarn.
Tow Warps. Tow Fillers.	2½″	A	0.023	0.098	O. K.	880% High	9 cord filler—13 picks per inch. 62 ends of warp per inch. (double strands) 2 cord warp yarn.
Tow Warps. Tow Fillers.	2½″	A-1	0.076	0.101	O. K.	910% High	11 cord filler—13 picks per inch. 68 ends of warp per inch. (double strands) 2 cord warp yarn.
Tow Warps. Tow Fillers.	2½″	A-2	0.073	0.063	O. K.	530% High	8 cord filler—13 picks per inch. 68 ends of warp per inch. (double strands) 2 cord warp yarn.

Notes on Hand Fire Extinguishers.

The problems connected with the maintenance and most effective use of "first aid" appliances are now generally recognized as deserving of more comprehensive study than they have hitherto received, and when this whole subject comes up for discussion on the report of the Committee on Field Practice in 1919 it will undoubtedly evoke widespread interest. In the meantime the subjoined notes on some recent developments in the manufacture of chemical extinguishers and on special difficulties that are being experienced consequent upon the scarcity of carbon tetrachloride will be of service to many N. F. P. A. members.

Hand Pump Fire Extinguishers.

With the advent of cold weather, the recurring problem of a thoroughly satisfactory hand fire extinguisher suitable for use in locations where low temperatures prevail again becomes one of urgent practical importance.

Salt has been and is used as a freezing preventive, but its limitations, as shown in the following table, and its other objectionable features, such as "creeping" and its more or less vigorous corrosive action on metal containers, render it at best but a poor safeguard against the attacks of frost.

Freezing Point of Salt Solutions.

Percentage of Salt to Water by Weight.	Freezing Point.
1 per cent salt	31.8 degrees F.
5 per cent salt	25.4 degrees F.
10 per cent salt	18.6 degrees F.
15 per cent salt	12.2 degrees F.
20 per cent salt	6.8 degrees F.
25 per cent salt	1.0 degrees F.

Calcium chloride of a high degree of purity, preferably re-precipitated and used in approved hand-pump extinguishers, seems to be the best protection at present available in low temperatures.* Under no circumstances, of course, should either salt or calcium chloride be used in an extinguisher of the "soda and acid" type.

The hand-pump extinguishers are cylindrical in shape and approximately 6½ inches in diameter by 26 inches in height for the 2½-gallon size, and 9¼ inches in diameter by 25 inches in height for the 5-gallon size, over-all dimensions. They are provided with a hose and nozzle without shut-off, and with a single-suction, double discharge pump mounted on top, by means of which they are operated. The extinguishers are usually charged with water where there is no danger of freezing,

* A table showing freezing temperatures of water with given quantities of calcium chloride in solution will be found in the *Proceedings* for 1918, p. 83.

or with a solution of calcium chloride in definite concentration according to the temperature against which it is desired to protect them.

Other important advantages of this type, in addition to its suitability for use at low temperature, are ease of inspection (which can be accomplished as often as desirable by merely operating the pump and directing the nozzle into a fill opening so that there is no loss of liquid), and the ease with which it can be recharged for immediate use.

When the device is being used for extinguishing fires, it is usually placed on the ground or floor and operated from a fixed position, as its method of operation prevents its being moved from place to place while the liquid is being discharged.

The number of these appliances inspected by Underwriters' Laboratories has recently increased considerably, owing in some degree to the requirements for protection of Government stores located in the open and in unheated buildings.

Foam Type Extinguishers.

One of the more recent developments in hand fire extinguishers is the foam type, 2½-gallon extinguisher, designed to extinguish fires by covering them with a smothering blanket of carbonic acid gas. The foam generated as the device is discharged floats on the surface of burning gasoline, oils, varnishes and other flammable liquids. This extinguisher is of the portable, loose stopple, inverting type, which upon inversion ejects a considerable quantity of tenacious foam. It is an adaptation of the 2½-gallon inverting type soda-acid extinguisher, in that the same form of shell, cap and outlet are employed, but instead of the usual acid bottle and cage a centrally located cylindrical receptacle closed at the top by a loose stopple is employed to contain one of the chemicals. The compartment formed by the outer shell contains a solution of sodium bicarbonate and the foam-producing material and the central compartment contains a solution of aluminum sulphate. When the extinguisher is inverted the two solutions mix to form foam and carbon dioxide, and the latter under pressure ejects the foam with considerable force.

The device is brought into action by simply inverting the extinguisher, the operating directions reading, "For Fire, Turn Bottom Up." The installation of the appliance is identical with that for the 2½-gallon soda-acid extinguisher, bracket clamps being provided so that it can be hung on a wall.

The charges for both compartments are usually shipped in separate cartons, one carton containing the foam-producing materials and the other powdered aluminum sulphate. The directions for using the contents of the cartons are indicated on each carton, and the general directions for recharging the extinguisher are given on a brass stamped label secured to the extinguisher.

The results of a long series of tests and investigations at Underwriters' Laboratories indicate that this type of extinguisher is effective on incipient fires where water or solutions containing large percentages of water are effective, excepting in loosely piled excelsior or similar materials which prevent the penetration of the foam to the seat of combustion. They are particularly effective on fires in hazardous liquids

wherever the foam is permitted to form a covering on the burning surface. They are especially adapted for refineries, garages and other properties involving storage and use of hazardous liquids. They must be protected against frost.

Scarcity of Carbon Tetrachloride.

(For Use in One-Quart Hand Fire Extinguishers.)

Carbon tetrachloride is so immediately necessary for war purposes that the Government has requisitioned all available supplies of this material, and it is understood that stocks in the hands of users have been listed for requisition if necessary. The indications are that, for some time to come, even a greatly increased production will scarcely suffice to make any surplus available for fire extinguishers.

Since this liquid forms the principal ingredient used in one-quart hand fire extinguishers, the provision of "re-fills" for extinguishers which may be used on fires from now on and the preservation of such extinguishers in case re-fills are not available constitute quite a problem. In many cases other types of standard first-aid fire appliance can be substituted for these devices until the latter can again be charged, so that the problem is somewhat more serious for existing installations than where new fire-fighting equipment is being provided.

Every extinguisher approved by Underwriters' Laboratories gives instructions for immediate refilling with a proper liquid after the device is used. This is because deterioration due to corrosion may set in if the device is left empty after having been filled with the regular extinguisher liquid, consisting largely of carbon tetrachloride.

Without detailed experiment it is somewhat difficult to make definite recommendations for protecting the internal parts of these extinguishers, and the efficacy of the following suggestions depends entirely upon the manner in which each individual charged with the care of the devices complies with them. Definite experimental tests are not practicable at Underwriters' Laboratories at the present time, but it is believed that if the suggestions are carefully followed a considerable measure of protection will be provided.

In preparing for storage extinguishers which have been emptied, first be certain that the extinguishing liquid has been removed as far as practicable. Do not put the extinguisher away without further care, but completely fill it with lubricating oil and operate it a short while to be certain that all interstices and movable parts have been coated with the grease. Then empty the extinguisher and close the fill opening tightly, lock the handle as directed and store the device where it will not be subjected to mechanical injury.

Make certain that no empty extinguisher is put back in its regular place and be sure to supply such substitute first-aid fire protection as may be practicable at the earliest moment.

When refills are again available, put in a small amount of the extinguishing liquid, shake thoroughly and discharge it in the regular manner so as to clean out all the preserving grease, which will be soluble in the extinguishing liquid. Then fill as usual and put into service.

Oxygen Tank Explosion at Austin, Texas.

Considerable interest attaches to the report presented to the Mayor and City Council of Austin, Texas, by a special committee formed to investigate an oxygen tank explosion which caused the loss of three lives and serious injuries to four persons in the garage of J. H. Eis in that city on August 19, 1918. The Chief Engineer of the State Fire Insurance Commission, Mr. Herbert H. Sutton (Member N. F. P. A.), was a member of the Committee, which, in addition to setting forth the probable causes of this particular disaster, made valuable recommendations, the observance of which would prevent similar disasters elsewhere.

Although the walls of the tank were so corroded in places as to reduce the thickness from one-fourth to one-eighth of an inch, the committee satisfied itself, after hearing expert evidence, that the latter thickness was ample to hold the 300 pounds pressure of the contents of the tank. Even making extreme allowance for possible change of temperature between the date of filling the tank and the date of use, it was impossible to explain the explosion by any weakness of the tank.

The occasion of the accident was as follows:

> Mr. Eis had just secured a freshly filled tank of oxygen and had prepared to burn the carbon out of the cylinders of a car, proceeding in the way a mechanic would and should.
>
> When the cylinders had been opened, Mr. Eis dropped a lighted match into one of them and inserted the nozzle of a copper tube, regularly used for this purpose, and which was connected with a rubber tube to the oxygen tank.
>
> As soon as he turned on the oxygen there was at first the usual small explosion always heard when oxygen is turned on in this connection, and immediately afterwards came the explosion which blew the container to pieces.
>
> It is evident from this procedure that the gas coming out of the tank was a mixture of oxygen and some combustible gas in such proportion that the lighting of the mixture in the mouth of the tube resulted in the travelling backwards of the flame through the connecting tube until it reached the contents of the tank and ignited it.

It was the unanimous opinion of the committee that the manipulation of the tank and the procedure to burn out the oxygen were strictly correct and careful in every detail. The fact that the trouble was due to conditions within the tank gives the circumstances a special interest to all who have occasion to handle oxygen in such containers, and we therefore reproduce in full the findings of the committee as to the possible causes of the explosion and the precautions which should be taken before starting to use the contents of newly-filled drums:

> We are also unanimously of the opinion that the explosion was due to the fact that the contents of the tank at the time contained a very explosive mixture of oxygen with a relatively large amount of combustible ingredient, either lubricating oil or gasoline, or hydrogen, etc.

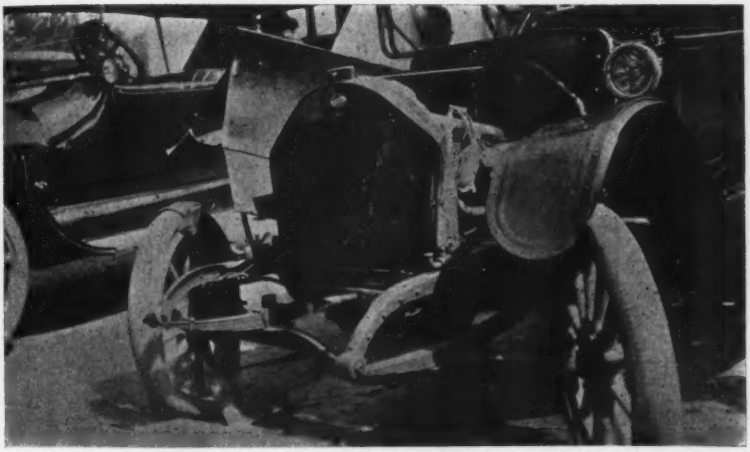


Fig. 1. Front and radiator of car upon which work was being done at time of explosion. Note bent fenders and damage to radiator. The lamps were blown off.

The tremendous force of the explosion, together with the fact that this was relatively low pressure oxygen, indicates that the proportion of combustible material must have been fairly high, because a few per cent of combustible material could not possibly have caused such a vigorous explosion.

Walker Plant Inquiry.

The committee also made an inspection of the plant of the Walker Refining Company, and found that Mr. Bailey Walker says that he tests the gas for explosibility before it is pumped into the containers.

There were several containers filled on August 19, one of which was the one which caused the fatal explosion.

Two of these tanks were used extensively—one by the mechanics at the garage of Estrada & Delzell on Trinity Street, between East Fifth and East Sixth Streets, and the other by the mechanic of Mr. Zilker's ice plant, Mr. Westergaard.

Messrs. Estrada & Delzell assured us that nothing unusual was noticed in connection with this tank or any other tank obtained from the Walker Refining Company, and an inspection of the copper tube they used for burning out oxygen showed it to be of a fairly large bore.

Hence, had the contents of their drum been explosive, the copper tube would not have acted to prevent the explosion.

Still another tank, said by Mr. Bailey Walker to have been filled on the same day as that on which the exploded tank was filled—August 19—was found at the Walker Refining Company's plant and was taken out to the chemical laboratory of the University of Texas, where, upon examination, it was found that it contained only 1½ per cent of hydrogen, which would not have caused even a feeble explosion, since the per cent of hydrogen would have to exceed 3 per cent before any explosion at all could be noticed.

Another Defective Tank.

We also found that a tank said to have been filled on August 15 had been sent to Anderson & Benson's garage, and there had caused surprise on account of the peculiar behavior of the gas, the gas being actually combustible and burning with a green flame, as the mechanic described it.

In our opinion the green color of the flame is unessential and is due primarily to the fact that it burned at the end of a copper tube; but the fact that a flame was obtained indicates that the contents of this tank also must have contained a high proportion of combustible material, and a disastrous explosion would have been obtained with this tank had it not been that the copper tube which forms the nozzle of the oxygen-burning apparatus used by Anderson & Benson was of such fine bore as to prevent the ignition of the gas backwards.

Fixes Responsibility.

An unbiased consideration of the facts before us forces us to recognize the following possibilities for the origin of the combustible material mixed with the oxygen in the tank that exploded:

1. That some oil—that is, lubricating oil or gasoline—was injected into the empty tank prior to its being refilled with oxygen.
2. That hydrogen was mixed with the oxygen as the result of the operation of the factory.

Both these sources of the combustible material appear to us to be possible sources.

The first of these appears to us to be possible from a simple consideration of the fact that someone may be led to inject some lubricating oil or gasoline into a valve.

Again, while the tanks are lying empty and awaiting refilling at the factory, they may have been tampered with in a similar manner.

The latter possibility is made very strong and hence becomes somewhat probable through the fact that deliberate tinkering with the valves of other tanks has taken place at the factory, three of them having been rendered absolutely unworkable through deliberate mistreatment, and the committee has been informed that there have been other instances of quasi-malicious small misdeeds around the factory; so that, on the whole, the possibility of the injection of combustibles into the tanks through agencies over which the manufacturers have no control cannot be denied.

It might be argued that the manufacturers should have tested the contents of the tanks before refilling them; but to this it may be answered that, beyond the ordinary visual examination around the valve of the tank, or observing the odor, manufacturers do not, as a rule, examine the contents of the tanks, and hence such injection of combustible material might have escaped the notice of the manufacturers of the oxygen while they were proceeding in the usual manner.

Of course, the possibility that the hydrogen mixed with the oxygen was the result of the operation of a plant also cannot be denied, even though the manufacturers have attempted by testing the gas to assure themselves that hydrogen in amounts large enough to form explosive mixtures is absent.

Conclusions of Committee.

In conclusion, we would say, then, that the tank exploded on account of the fact that the oxygen was contaminated with a considerable amount of a combustible material.

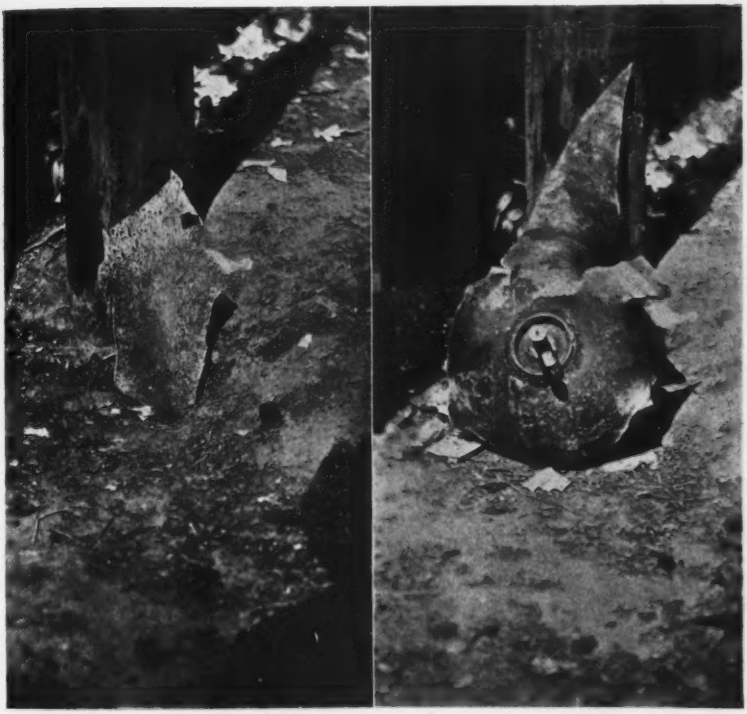
We have been unable to learn the exact nature of this combustible material, and have merely presented some possibilities of its source.

To prevent the recurrence of such accidents, we recommend that your honorable body secure the rules and regulations covering the use of oxygen and hydrogen within the city of New York, and require compliance with these rules and regulations as far as they seem to be applicable to our city.

In the meanwhile we also recommend that every user of oxygen, before starting to use the contents of a newly filled drum, test the same by the following simple procedure:

Some of the gas should be allowed to pass through a rubber tube into some water, and the bubbles should be caught in a test tube filled with water and held in an inverted position, so that the oxygen bubbles will rise up in the test tube and displace the water.

When all the water has thus been displaced by oxygen, the test tube should be closed with the thumb and removed from the water.



Figs. 2 and 3. Fig. 2 (on left) shows inside of fragment of drum with signs of corrosion. Fig. 3 (on right) gives view of top of drum from outside.

A glowing splinter should have been prepared in the meantime, and this glowing end of the splinter should be thrust quickly into the test tube, the thumb having been removed just before the insertion of the glowing splinter.

A slight popping noise will be heard when the glowing splinter touches the mouth of the test tube, but it should not be an explosion or flame travelling down into the test tube; instead of this, the glowing splinter thrust within the test tube should burn or glow vigorously.

A little experience will soon train a man so as to enable him to distinguish between an explosive mixture and fairly pure oxygen.

These precautions will, in general, eliminate the possibility of danger attending the use of oxygen.

Hal C. Weaver.
Herbert H. Sutton.
Hood Pitts.
E. P. Schoch, *Chairman.*

Factory Holocaust at Newark, N. J.

September 17, 1918.

Almost coincidently with the promulgation of the recommendations of the N. F. P. A. Committee on Safety to Life for the regulation by law of the occupancy of factories, there occurred in Newark, N. J., at the plant of the American Button Company, a fire which took a toll of eleven lives—nine girls, a man and a boy. The Coroner's investigation disclosed the fact that the company had for some time been disregarding the laws of the State of New Jersey and the regulations of the Building Department of the City of Newark. It was clearly shown, however, that under existing conditions of divided responsibility for the enforcement of the various legal requirements, it was extremely difficult, if not impossible, to secure prompt compliance with orders for specific improvements or to detect immediately omissions of duty and small but hazardous installations in contravention of the law. Thus the Superintendent of the City Building Department was aware of the poor protection of the stairways, but had no authority to compel the provision of the needed fire-resistive partitions; he was waiting for an opportunity—which never came—to render the factory safer by making any permit for other alterations conditional upon the improvement of the stair enclosures. The State Department of Labor, which had authority to order the necessary improvements and which had, in fact, so long ago as November 27, 1916, directed the construction of fire-retarding doors and stairways, was not in a financial position to arrange for more than one inspection a year, except in the case of "extra hazardous" plants, and that inspection covered not only fire protection, but accident prevention, sanitation and hygiene, child labor conditions and other phases of industrial life. Moreover, although the city authorities were alive to the dangers of the stairway conditions which they could not remedy, they had been kept in ignorance of the installation in the lacquer room of a blower fan and motor, six feet distant from the lacquer spraying apparatus, in a wooden casement beneath a wooden staircase and adjoining a wooden cabinet filled with paper. A spark in this motor, which had not been inspected as required by the city building code, was the cause of the fatal fire.

Mere recital of the facts is sufficient to show the advantages of the method of regulation suggested by the Committee on Safety to Life. Although actual measurements are not available, it may be taken for granted that the operation of the factory under the conditions that obtained at the time of the fire would have been impossible under the Committee's rules. As members who have followed the discussions on this subject at the last two Annual Meetings will remember, the Com-

mittee's plan is to have the exit capacities of all factory buildings measured and the safe permissible number of workers on each floor determined according to a fixed scale of allowances based on construction, condition of vertical openings, sprinkler protection and the type of occupancy. The allowances were so fixed as to penalize inferior construction and poorly protected openings so heavily as to render the conditions of operation in the poorest types of buildings distinctly onerous to the management. At the same time, generous treatment in respect of occupancy is meted out to really good construction and protection. Under the Committee's rules the total number of employees permitted in the factory would have been automatically reduced by the lack of stair protection, and this fact would probably have helped to stimulate the company's interest in the hazardous condition. Moreover, unless the company was normally employing considerably less people than the factory would safely hold—which seems highly improbable—difficulties arising from the presence of an abnormal number of employees in times of pressure could not arise. There seems little doubt that overcrowding from this cause was an important factor in the failure of the employees to make their escape in time.

As already mentioned, the fire started at an electric motor installed near a lacquer spraying machine. This was on the second floor. An employee threw a pail of water on the burning motor, which was covered with dried lacquer. This failed to extinguish the blaze, and in the meantime other employees endeavoring to make their escape had become panic-stricken.

It appeared that all might have gotten out safely if they had been under discipline, as a man across the street said that he saw eighteen or twenty girls on the fire escape before either smoke or fire was visible. The spread of the fire was unusually rapid, as the floors were all open, and the lacquer burned with astonishing fierceness, the Deputy Fire Chief testifying that it was one of the fiercest and quickest fires he had known. Sickening fumes were also given off by the lacquer. The factory superintendent, who was among the survivors, was partially overcome by fumes on one of the interior stairways, but recovered sufficiently to make his way out of the building.

More than ten of the employees testified that there had been no fire drills for more than a year prior to the fire, and that no instructions or directions were given to the employees as to procedure in the event of fire. The Coroner's jury also regarded as conclusive the evidence that the fire alarm system was used for other purposes, and was not strictly confined to the giving of warning in case of fire.

The building was a three-story-and-basement brick structure of ordinary construction. The interior stairs were enclosed by wooden partitions of single board thickness, and wooden trapdoors held open by chains equipped with fusible links were provided at the third floor. The trapdoors closed automatically by the fusing of the links, but the upward spread of fire and smoke was not sufficiently retarded to enable all the occupants on the third floor to escape. All the dead were found on the third floor, and the medical testimony was that they had been suffocated. One of the victims had reached a place of safety, but returned for a sweater.

The building was equipped with an outside "new law" straight-run fire-escape protected by wired-glass windows, with doors at floor levels, but in the exceptional circumstances the exits proved altogether inadequate.

The principal lessons to be drawn from the disaster may be summarized as follows:—

1. The enforcement of all orders for the provision of proper safeguards against fire should be prompt and thorough.

2. Factory superintendents should be made to understand, by the imposition of rigorous penalties if necessary, that state laws requiring periodical fire drills must be observed to the letter.

3. To instal electrical equipment unknown to the authorities legally responsible for the inspection and approval of such equipment is an act of criminal folly.

4. It is the manifest duty of the superintendent of a factory using hazardous fluids such as lacquer to acquaint himself fully with the properties of the particular preparations handled. The superintendent of the American Button Company pleaded ignorance of the hazards of the lacquer which was an important factor in spreading the fire so quickly.

5. It is even more important during seasons of pressure involving the employment of extra help than at other times to have the employees periodically and thoroughly instructed what to do in case of fire. The probabilities of overcrowding and confusion in an emergency under such conditions are much greater than in normal times.

Department of Fire Record.

Rubber Works—Fire Record.

The present study covers practically all the fires in rubber works that have been reported to the Association, only a few old fires in respect of which insufficient information is available being excluded. Out of a total of 263 fires, only 60 were attributable to common causes and no more than 35 to causes unknown—facts which point to generally good housekeeping in the industry. The proportion of "large loss" fires is not excessive, and sprinkler equipments are the rule rather than the exception.

By far the largest causes of rubber factory fires are static electric sparks and the ignition of inflammable vapors, the two being so closely associated that it is difficult to draw any hard and fast line between them. It is interesting to note how the record tallies with the investigations of Mr. F. J. Hoxie (Member N. F. P. A.) quoted in the QUARTERLY for July, 1917 (Vol. 11, No. 1, p. 75) as to the periodicity of fires due to static electricity. A tabulation according to months of the 73 fires of this general character included in the record shows the following:

	No. of Fires.
January	10
February	21
March	8
April	13
May	1
June	0
July	0
August	2
September	2
October	5
November	6
December	4
Exact date uncertain	1
Total	73

These figures, which were obtained from a wider geographical field and over a longer period of years than were covered by Mr. Hoxie's detailed and comprehensive studies in New England factories, differ somewhat from his results in respect to the distribution between the months from November to April, but they amply confirm his general conclusions regarding the increased incidence of such fires during the winter months.

The problem of grounding, and keeping effectively grounded, all machines at which static electricity is likely to be generated has not yet been completely solved, though it would appear that in some factories the hazard from this source has been much more efficiently taken care of than in others. Inasmuch as these fires are frequently attended with serious injury to the employees, and occasionally loss of life, it is an obvious duty of good management to take every possible precaution to safeguard this hazard. Use of the Chapman neutralizer* and of appliances for humidifying the atmosphere and thorough grounding—in some cases of the employee as well as the apparatus—are the most generally recognized remedies.

Hazardous processes like spreading and cement mixing should be conducted in properly isolated buildings or rooms, and material waiting to be spread should not be kept in a location to which a fire originating at the spreader machine may easily communicate. To store valuable goods underneath rooms in which spreading is done is also bad practice, and several instances have been reported involving heavy damage when water used to extinguish a spreader fire ran down into floors below.

Naphtha, gasoline and benzine should, of course, be stored in an approved manner, and the utmost care is necessary in the matter of lighting in the presence of inflammable vapors. If it is necessary for a watchman to pass through the cement-mixing room, he should not be permitted to use an ordinary lantern, and while an ideal condition might be the complete prohibition of artificial light in buildings or rooms in which hazardous liquids or solutions are stored, it is certainly better to have a well-installed system of electric lamps with keyless sockets and vapor-proof globes than to omit all provision for illumination and use open lights in times of emergency when the factory may be in operation at night.

On the whole, the not unsatisfactory character of the record emphasizes the fact that the chief cause of the fire waste is not the presence of hazards too severe for human control, but a false sense of security in relation to hazards that do not seem severe enough to be worth the exercise of ordinary human intelligence to combat. From this point of view the record of the rubber industry might profitably be studied by owners and managers of other classes of property possessing fewer and smaller inherent hazards.

* See "Fire Hazards in Rubber Mills," Vol. 11, No. 1, p. 75.

RUBBER MILLS—FIRE RECORD.

Total Number of Fires Reported, 263.

1. Classification of Causes.

Common Causes.

	No. of Fires.	Per Cent. of Common Causes.	Per Cent. of Known Causes.
Heating	9	15.0	3.9
Lighting	6	10.0	2.6
Power	6	10.0	2.6
Lightning	3	5.0	1.3
Smoking (or matches)	14	23.4	6.1
Chimneys (or flues)	2	3.3	.9
Boiler (or fuel)	3	5.0	1.3
Rubbish (or sweepings)	5	8.3	2.2
Oily Material	5	8.3	2.2
Locomotive Sparks	3	5.0	1.3
Miscellaneous	4	6.7	1.8
Total	60	100.0	

Special Hazard Causes.

		No. of Fires.	Per Cent. of Special Causes.	
Static Electric Sparks:				
At Spreading Machines	33			
At Stripping Machines	3			
At Spot Proofing Machines	2			
At Calender Roll	2			
At Coating Machines	2			
At Cutting Machines	2			
At Brushing Machine	1			
At Covering Machine	1			
At Curing Machine	1			
At Sizing Machine	1			
At Churn	1			
Ignited Sulphur Dust	3			
Miscellaneous and no data	21	73	44.5	32.0
Ignition of gasoline, benzine, and naphtha vapors		26	15.9	11.4
Drying		19	11.6	8.3
Spontaneous combustion in rubber, rubber scrap, etc.		10	6.1	4.4
Cement Mixing		10	6.1	4.4
Ignition of Carbon Bisulphide		4	2.4	1.8
Grinding		2	1.2	.9
Miscellaneous		20	12.2	8.8
Total		164	100.0	
Common Causes		60		26.2
Special Hazard Causes		164		72.0
Incendiary		1		.5
Exposure		3		1.3
Total known causes		228		100.0
Unknown causes		35		
Total		263		

Details of Causes.

Under this heading are given brief descriptions of fires caused by unusual conditions or of an educational value in emphasizing the different hazards. Fires caused by ordinary conditions or well understood hazards may not be included.

Common Causes.

Lighting.

S-12167. A billing machine in the office was equipped with a small electric light to enable the operator to see the work under the machine. The operator, before leaving for the day, spread a rubber cover over the machine. A little later another employee noticed an odor of burnt rubber, and found that the wiring for the electric light had become short-circuited on the metal framework. All the rubber parts of the machine were burned out and the metal work so warped that it could not be repaired. There was not enough heat generated to open any sprinklers.

Oily Material.

S-11177. Fire was caused by spontaneous combustion in waste rags or oily clothing thrown under a large bench used in connection with the manufacture of hose. The bench was 40 feet long and 3½ feet wide, and obstructed the distribution of water from the 15 sprinklers which operated. Everything under the bench was consumed, the legs and under side being also badly charred. There was no excuse for this fire, as plenty of metal-covered cans were provided for dirty rags, and there was a proper place for the disposal of oily clothing.

Miscellaneous.

S-238. Watchman had cleaned the boiler fires fifteen minutes before the fire started, and had rested a hot furnace hoe on combustible material. The room was protected by automatic sprinklers which were shut off in winter. In the excitement the watchman did not think to open the controlling valve, and the ten sprinkler heads which opened were consequently useless. The fire was extinguished by the city fire department.

S-7356. Watchman was mixing some benzine cement for his own use when it caught fire from his lantern. One sprinkler operated and extinguished the blaze.

Special Hazard Causes.

Static Electric Sparks.

H-781. An employee was standing near to an elevator shaft and filling a small naphtha can. In changing position his elbow came in contact with a belt, causing an electric spark which ignited gases from the naphtha. An explosion followed and flames quickly passed up the elevator shaft. The property was totally destroyed, with a loss of about $250,000.

S-3955. At the time of the fire a boy in the cement mixing room was cutting off sheet rubber from a roll and placing the pieces in an iron can of cement mixture. No artificial light was in use. A static spark of electricity generated in pulling the rubber from the roll set fire to cement. The building contained six or seven drums of naphtha, seventeen iron barrels of rubber cement and several tanks used for mixing the cement, one of which was nearly full. There was also a barrel of kerosene, together with miscellaneous supplies. Eight sprinklers operated and hose streams were laid very promptly. The cement and naphtha were removed from the building and the fire was extinguished with small loss. The fire was extremely well handled, and great credit is also due to the sprinklers.

S-4370. A sheet of rubber cloth was being removed from a zinc-covered table after being covered with cement. The friction of removal caused a spark of static electricity and the cement suddenly ignited. The fire was extinguished promptly with pails of sand.

S-6193. Sacking was being stripped from bales of crude rubber, naphtha being used to facilitate the process. About two quarts of naphtha were at hand. An electric spark is believed to have been discharged by the cleaving of the sacking from the rubber, and naphtha was ignited. Sprinklers operated promptly and extinguished the fire.

S-13959. A small lump of cement had passed the knife on a spreader machine and an employee was removing it with a small hand knife when the flash occurred. Two sprinklers operated and employees used two lines of steam hose for about fifteen minutes. There was slight damage by fire to an adjoining spreader, some of the burning fabric from the first machine having been permitted as it was pulled away to come in contact with fabric on the second. Fire occurred in the third story, and water ran down to the basement, where it did some damage to stock. Fortunately there was no stock within range of the water on the intervening floors. The loss was about $1,100.

S-14445. Benzol and carbon tetrachloride were present in proportions of 3 and 1 respectively in the fluid used at a curing machine, and it was therefore considered that there was not much danger of a flash. Vapors from the shallow tank containing the mixture were, however, ignited by a static spark. The fire was extinguished with slight loss by sprinklers and steam hose. Holes in the walls at the floors, designed to permit the escape of heavy vapors, acted as scuppers and prevented considerable water damage.

S-19067. Rolls of cotton duck used as breaker strips under the treads on automobile tires were impregnated by passing the duck under metal rollers contained in a tank holding about 15 gallons of rubber cement. The fabric was then dried by hanging it in loops over metal rods suspended near the ceiling by pulleys. It was allowed to remain overnight and was then ready for use. The room was cool owing to the low temperature outside, and in pulling the fabric over the metal rods static electric sparks were generated, causing a flash which quickly

spread over several 50-yard rolls of fabric and into the cement tank. Fifty-three sprinklers operated, and so efficient was their work that the ceiling was only slightly scorched. The loss was small.

S-21259. Fire occurred at one of the spreader machines, evidently due to static electricity. A window had been opened only a few minutes previously, and it is believed that the cold air thus admitted was a factor in causing the fire.

S-21575. Very heavy material which had been saturated with rubber cement in another process was being wound back over the spreader preparatory to the application of more rubber, when fire occurred from static spark. Four humidifier heads were in operation at the time of the fire, but the spreaders had a ventilating device which carried away vapor from the drying fabric and also a considerable quantity of air. Air entering the room by open doors might have been drawn over the spreaders before being humidified by the heads. The loss was slight.

Gasoline, Naphtha, Rubber Cement, Etc.

H-10390. Fire occurred in the churn room when the watchman entered with a lantern on his regular round. The room contained six large sheet-iron mixing churns, 4½ feet in height and 3 feet in diameter, having their tops made two-thirds of sheet metal riveted on, with wood covers, tightly fitting into the tops but not secured in place, over the remaining third. Besides these large churns, there were sixteen small churns of 30-gallon capacity. All the small churns had movable wooden covers with square holes in the center to allow shafts to pass through. The shafts were round, and naphtha fumes could easily escape through the openings. When the watchman started to cross the room, his lantern burst into flame, and instantly the whole room was ablaze. The watchman showed great promptness and presence of mind in turning in an alarm and securing assistance from other watchmen. Hose streams were brought into effective play before the wooden churn covers were burned through, and cement was thus prevented from taking fire. Damage to belts and woodwork in the room amounted to about $2,000. A tin-clad fire door between the churn and grinding rooms resisted the fire admirably.

An ordinary watchman's lantern is quite unsuitable for use in visiting rooms in which inflammable vapors are likely to be present.

S-13987. In nailing up a case containing two cans of rubber cement, a nail was driven into one of the cans. Considerable cement leaked into the case, and when one of the cans was removed sufficient friction was caused to ignite the cement. Fire spread to combustible material nearby and caused a loss of $900.

S-16709. A workman was carrying a pail of gasoline and a pail of cement from the supply tanks to his work table. In passing through a rather narrow space between a pile of tires and a portable electrically-driven press for drilling valve holes in tires, he struck his gasoline pail against an exposed electric switch, immediately setting fire to the con-

tents and spilling them over the floor. The burning gasoline and cement set fire to several piles of finished tires, damaging about 112 of them. Four sprinklers operated promptly and held the fire in check.

H-12421. The cement mixing building was a small one-story frame shed located three feet distant from a frame garage and about 60 feet from the north end of the main buildings. There was no light or heat in the shed and the factory was operating nights. An employee went to the shed at about 10 p. m. and, lighting a match, put it down into a pail that was half full of cement to see how much cement there was. The contents immediately ignited, and in a few seconds the entire shed was on fire. The employee received severe burns, the shed was practically destroyed and a portion of the west wall of the frame garage was damaged.

S-20803. An employee was washing rubber cement from his hands with gasoline near a cement mixer. Another employee was experimenting with an automatic cigar lighter and accidently ignited the gasoline. The fire spread to the cement mixer and to an open can of gasoline, but was extinguished with chemical extinguishers and water pails before sufficient heat was generated to operate sprinklers. The man who was washing his hands was badly burned, but the property loss was slight.

S-21351. An electric spark generated by rubbing or from a static charge on employee's body caused a can which was being cleaned from a mixer with gasoline and a cotton cloth to burst into flames. The employee threw the blazing can out of doors, but not in time to prevent the fire from jumping to tank containing gasoline. Sprinklers connected to a steam line operated promptly, but apparently were of little value, the fire being extinguished with hose streams and sand after the roof had been badly burned and the equipment more or less damaged.

Bisulphide of Carbon.

S-12423. Curing was carried on in two independent heaters in the room in which fire occurred. The material was looped over bars, and at each side of the heater at the floor were located two rows of steam pipes. A mixture composed of equal parts of chloride of sulphur and bisulphide of carbon was put in an ordinary soup plate and placed on the steam pipes through an opening in the heater. About fifteen minutes after the acid had been placed on the pipes the superintendent saw a flame around the opening at the bottom of the heater. A small hose stream was immediately used and the fire confined to the heater. The cause of the blaze was ignition of bisulphide of carbon due to heat from the steam pipes. The loss was $282.

S-15005. Carbon bisulphide was kept in a 200-lb. drum in the oil room, and provision was made for drawing the liquid by a cast-iron plug faucet screwed into the side of the drum at one end. An employee, in attempting to turn the faucet, broke it off at the drum, allowing the liquid to run onto the floor. As he jumped to get something with which to plug the drum, he was enveloped in a sheet of flame. The supposition is that in his rapid movement a nail in his shoe struck a spark in

contact with the concrete flooring, and thus ignited vapor from the liquid. Another employee also was badly burned about the feet and hands. In the oil room at the time of the fire were small tanks of oil, rubber cement in tubes and cans, and safety cans for transportation into the factory of naphtha and benzol. On top of the drum of carbon bisulphide was a 10-gallon can of wood alcohol. None of the liquids or oils in the room were ignited except small quantities of naphtha and benzol in drip pans under pumps. A fire door between the oil and cement rooms was closed by an employee at the beginning of the fire and prevented any damage in the cement room. Burning liquid that ran under the fire door into the cement room was easily extinguished. Window frames and sash in the oil room were severely damaged, and the naphtha and benzol pumps were so badly overheated as to require overhauling.

H-11052. During the process of dipping rubber nipples in an open stone crock containing two quarts of bisulphide of carbon, a portion of the chemical was accidentally dropped on highly heated steam pipes passing through the dipping room. The vapor ignited and fire ensued, which was finally extinguished by the city fire department. The building was frame construction, with open joisted ceiling.

Hazardous dipping of this character should be done in a fire-resistive building well ventilated and separated from the main buildings of the plant.

Ignition of Sulphur Dust.

S-13953. Two men were pouring the contents of a barrel of flowers of sulphur onto a sieve enclosed in wooden boxing, when a flash and slight explosion occurred. The men, who were slightly burned, immediately left the room, and the mill fire brigade easily extinguished the fire with a hose stream. The principal damage was by water to compounding materials. The probable cause of the fire was ignition of sulphur dust by a static electric spark. The day was dry and cold and the friction of the particles of sulphur over each other on the sieve would produce the necessary charge. Although the sieve itself was metal, it was insulated from the ground.

S-16340.
S-16384. Three fires occurred within a month in a conveyor which delivered sulphur to a sifting machine located on the top floor of the composition house. From the bottom of an iron hopper sulphur was drawn by a worm to the bottom of a vertical canvas belt conveyor with galvanized iron buckets. It then passed up the conveyor, down a chute into a movable tray of the sifter, and through a cylindrical screen to a bin below. The conveyor was entirely enclosed in galvanized iron boxing. While the operator was at work with an iron rake clearing away sulphur from the bottom of the chute, which often becomes clogged, a slight explosion took place. Fire appeared immediately at the conveyor and sifter. It could not be determined with certainty whether the sparks which ignited the sulphur dust were due to static electricity or to friction due to mechanical defects in the apparatus. The total loss from the three fires was between $300 and $400.

MISCELLANEOUS STATISTICS.

2. Analysis of Loss.

	Common Causes.		Special Causes.		Unknown Incendiary Exposure.		Total.	
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.
No Claim	13	22	23	15	5	13	41	16
Small Loss	43	72	123	79	23	61	189	74
Large Loss	4	6	10	6	10	26	24	10
Total with data given	60	100	156	100	38	100	254	100
No data	0		8		1		9	
Total	60		164		39		263	

3. Day or Night Fires (Day Fires 6 a. m. to 6 p. m.)

	Common Causes.		Special Causes.		Unknown Incendiary Exposure.		Total.	
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.
Day	27	45	132	83	17	45	176	68
Night	33	55	28	17	21	55	82	32
Total with data given	60	100	160	100	38	100	258	100
No data	0		4		1		5	
Total	60		164		39		263	

4. Plant in Operation.

	Common Causes.		Special Causes.		Unknown Incendiary Exposure.		Total.	
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.
Plant in Operation	31	58	144	91	17	49	192	78
Plant not in Operation	22	42	14	9	18	51	54	22
Total with data given	53	100	158	100	35	100	246	100
No data	7		6		4		17	
Total	60		164		39		263	

5. How Discovered.

	Common Causes.		Special Causes.		Unknown Incendiary Exposure.		Total.	
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.
Employee	32	58	143	90	18	47	193	76
Watchman	16	29	14	8	11	29	41	16
Sprinkler Alarm	4	7	1	1	2	5	7	3
Outsider	3	6	1	1	7	19	11	5
Total with data given	55	100	159	100	38	100	252	100
No data	5		5		1		11	
Total	60		164		39		263	

SPRINKLER FIRE RECORD.*

6. Effect of Sprinklers.†

	No. of Fires.	Per Cent.
Extinguished or Practically Extinguished Fire	80	52.3
Held Fire in Check	65	42.5
Unsatisfactory	8	5.2
	153	100.0
No Claim	28	18.3
Small Loss	112	73.2
Large Loss	10	6.5
No data	3	2.0
Total	153	100.0

* There were 48 fires in which no sprinklers were opened.

† 10 fires included in this table are omitted from subsequent tables owing to insufficiency of data.

7. Number of Sprinklers Opened.

No. of Sprinklers Operating.	Extinguished Fire.		Held Fire in Check.		Unsatisfactory.		Total.	
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires	Per Cent.
1	23	30.3	12	19.0	..	..	35	24.4
2	13	17.1	11	17.5	..	..	24	16.8
3	8	10.5	5	7.9	..	..	13	9.1
4	5	6.6	6	9.5	..	..	11	7.7
5	5	6.6	2	3.2	..	..	7	4.9
6 to 9 incl.	7	9.2	6	9.5	2	50.0	15	10.5
10 to 24 incl.	12	15.8	11	17.5	..	..	23	16.1
25 to 49 incl.	2	2.6	6	9.5	..	..	8	5.6
50 and over	1	1.3	4	6.4	2	50.0	7	4.9
Total	76	100.0	63	100.0	4	100.0	143	100.0

Unsatisfactory or Large Loss Sprinkler Fires.*

S-3992. The building was light joist construction, the sprinklers were of an old type, and the primary water supply was a gravity tank of only 3,000 gallons capacity, with an elevation of no more than 9 feet. About 100 sprinklers operated but the initial pressure was not above 7 pounds. Large quantities of rubber cement and naphtha were present, together with about 15 gallons of carbon bisulphide, making the fire a very hot and rapid one. It was stated that fire pumps were in service before the gravity tank was drained, but these were required to supply four hose streams in addition to the sprinklers, so that the pressure on the latter cannot have been good. The loss was heavy.

S-8437. At the time of the fire the man in charge had just finished boiling a batch of rubber cement, and was removing it from the kettle in which it is made to small storage cans kept outside the building. Suddenly a dipperful of the cement burst into flames as it was being transferred to a can, and the fire flashed back to the kettle. Six sprinklers operated but the water served only to overflow the kettle and so spread the fire. Fire doors communicating with other rooms were closed and the blaze was confined to the room of origin until the fire department arrived and extinguished it. The loss amounted to about $700.

S-8850. The cement mixing machine was run by an induction motor inside the boiler house which adjoined the cement house, the belt connection being covered by a wooden beltway. Gasoline was pumped into the cement house from an iron tank outside by a pump located in the house near the mixing machine. Just before the disaster the foreman found that the machine was stuck, but how the trouble originated could not be ascertained. It was claimed that not more than two gallons of gasoline were in the mixer at the time. Suddenly there was a gasoline explosion and the roof was blown completely off. The walls also were blown down with the exception of two to three feet at the sides and ends respectively. Three employees were very seriously injured and the sprinkler piping was of course wrecked. The loss on the cement building and contents was total.

S-10630. This fire entailed a loss of about $267,000. The cause is unknown and it could not be determined with certainty whether post indicator valve controlling the sprinklers was closed at the time of the fire or whether the failure was due to a frozen riser. On examination on the day after the fire the whole riser was found frozen, making it impossible to ascertain whether there had been ice in the pipe at the time of the fire. The firemen saw no water coming from the sprinklers and no one heard the sprinkler alarm, although a large rotary gong and a bell in the engine room should have operated. The riser had

* See also Fire **S-21843,** page 222.

been protected below the first floor by boxing about 14 inches square packed with sawdust. The boxing extended 3 feet downward from the floor, and when built probably reached the ground. When examined after the fire, however, a hole was found around the riser, exposing it for about 3 feet. There are three possible explanations of the formation of the hole:—(1) a washing away of the earth by the water from the draw-off valve, (2) an excavation made to facilitate the erection of the frostproof boxing, (3) a general settling of the earth when refilled around the piping. A combination of causes (1) and (3) was considered very probable. The riser passed up within a few inches of a window and freezing may therefore also have occurred above the floor. The minimum insulation of 3 inches given by the boxing was possibly insufficient in extreme weather, even had the pipe not been otherwise exposed.

Points of Interest from Fire Reports.

Automatic Sprinklers.

S-7467. Overheated woodwork in a dryer was probably responsible for this fire. There being no sprinklers in the dryer the fire gained considerable headway before any of the heads outside operated and helped to extinguish the flames. The loss exceeded $15,000.

S-18377. There were four unsprinklered dryers or "heaters" of wood, tin and asbestos lined, with steam coils on bottom and sliding trays of wood and wire net above, on which wet rubber was spread. The fire was discovered in one of the dryers on the morning of a holiday, after the watchman had opened the doors of the dryers and turned off the heat. The watchman and an employee endeavored to extinguish the fire with chemical extinguishers, while awaiting the arrival of the fire department, but proving unsuccessful they shut the door to confine the fire and smoke within the dryer. When, after considerable delay, the department arrived, the smoke had become so thick that the room was difficult to enter. At first the firemen played their hose streams at random in the room, and when at length the door of the dryer was opened, they failed to keep the flames from penetrating the ceiling and causing eleven sprinklers to operate, two of these being in the story above. A hole was then cut through a doorway in a brick wall at the back of the dryers but the only result of this was to allow the fire to come through and communicate to the floor above. At last hose streams reached the dryer and quickly extinguished the fire. A great part of the loss of $4,785 might have been avoided if the dryer had been sprinklered.

S-19013. The wooden sides and top of a dryer were lined with asbestos, steam pipes being located at the floor with a wooden rack above for holding the materials. The roof of the dryer was even with the bottom of the joists of the room from which it was partitioned off,

thus leaving a concealed space of about 8 inches. There were no sprinklers in the dryer or concealed space. Next to the door of the heater were racks on which was kept material to be dried. Fire occurred inside the dryer, resulting in the practical destruction of its interior and contents and some damage to the joists in the ceiling above.

These three fires are good examples of the results of leaving sprinkler protection incomplete by the omission of sprinklers in such locations as dryers.

S-4177. Fire started in a wood, metal-lined unsprinklered dry box which stood beside a frame elevator partition. The watchman was notified of the fire by the ringing of the sprinkler alarm gong on the outside of the building. Immediately afterwards he discovered the location of the blaze and summoned the fire department. The fire had doubtless been burning several minutes before discovery and as a result of poor spacing at this point (there being no sprinkler near to the box) flames spread in several directions causing twenty-three heads to open. The frame elevator partition was also burned through, as was the elevator trap, and consequently two more sprinklers operated on the floor above. By pumping water into the system through the steamer connection, the fire department undoubtedly prevented a serious loss, as the 8,000-gallon gravity tank which was the only other source of supply was being rapidly emptied through the large number of sprinklers that had operated.

S-12055. The floor and ceiling of that part of the factory in which fire occurred were metal-clad, the floor metal being turned up about 6 inches all around the area with the view of preventing water on burning naphtha from spreading along the floor. The area thus protected was drained to a nearby river by means of a pipe through the floor. Employees fought the fire with chemical extinguishers and wet burlap kept handy for just such an emergency. The firemen accidentally tipped over a tub of naphtha on their arrival, thus making the situation worse. Eighteen sprinklers operated but the water did not, of course, extinguish the fire. It did, however, keep the walls and ceiling cool and must have also kept the flames down. The walls would undoubtedly have taken fire had it not been for the sprinklers, yet after the fire the building did not show the least trace of fire. The loss was restricted to contents.

First Aid Fire Appliances.

S-20702. Fire occurring in a gasoline tank as the result of a static electric spark at a spreading machine was promptly extinguished by employees who threw wet rags on the tank and used six or seven chemical extinguishers. Large tubs of burlap rags soaked in water were kept close to the machine as they had been found to be effective in choking gasoline fires.

Housekeeping.

S-13746. A loss of about $4,571 resulted from a small coating machine fire. This was largely water damage to a quantity of finished goods stored on the floor below in a quite unsuitable location beneath

the machine, at which occasional fires due to static electric sparks were to be apprehended.

S-20765. This fire was extinguished in about twenty minutes, but during that time $13,500 damage was done. The unwise practice had been followed of storing large quantities of goods in the spreader room, and these naturally suffered severely when fire originating in a static electric spark occurred at the spreader machine.

Miscellaneous.

H-4142. The attic in which this fire occurred was located over the office and was used for the storage of ground springs (scrap and shoddy rubber after grinding) and fabric. Occasionally men would change their overalls here. The office was on the first floor separated by a division wall from the milling room, with which it formed a section 40 x 185 feet in area. The cause of the fire is unknown but ground springs, if damp, are liable to spontaneous combustion. It is believed that the watchman had not visited this part of the plant as he should have done, and that the fire had been smouldering for some time prior to its discovery. The watchman, smelling smoke shortly after 4 a. m., went up the stairway at the division between the office and the mill room and opening the fire door into the attic over the office found it ablaze. He claimed to have closed the door before running downstairs to give an alarm, but the firemen first responding alleged that they found fire already in the attic over the milling room, where crude rubber was drying. This burned rapidly and fiercely, generating great heat and smoke. The attic being low and accessible only by stairways, the firemen had to cut holes in the roof. There were several metal ventilators in the roof and the quick spread of the fire along the wood sheathing was aided by the draft from the ventilators. The damage, which was confined mainly to the stock of crude rubber, amounted to about $100,000.

S-14072. This fire is interesting as showing the importance of equipping fire doors with fittings of standard weight. When fire occurred in an adjoining building the catch on a fire door was found to be sufficiently bent to leave space around the top of the door, through which the flames communicated to a wooden beam overhead and then to sheathing under the roof. The loss was considerable.

EFFICIENCY OF WATER SUPPLIES TO SPRINKLER SYSTEMS.					Number and Per Cent. of Fires.						Average Pressure.			Average Number Sprinklers Opened.	
Primary Water Supply.	Number of fires	Per cent. of fires	Average pressure	Average number sprinklers opened	Extinguished fire (or practically extinguished)		Held fire in check		Unsatisfactory		Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Extinguished fire (or practically extinguished)	Held fire in check
Water works,	101	70.6	60	7.40	53	52.5	45	44.5	3	3.0	60	60	61	4.92	10.31
Gravity tank,	29	20.3	32	14.93	14	48.3	14	48.3	1	3.4	33	32	7	10.86	19.00
Pressure tank,	6	4.2	86	7.16	6	100.0	....	.....	....	....	86	....	....	7.16	.....
Automatic pump,	7	4.9	81	2.00	3	42.9	4	57.1	....	....	77	84	....	1.66	2.5
Total	143	100.0	56	8.63	76	53.1	63	44.1	4	2.8	58	55	50	6.07	11.73

EFFICIENCY OF WATER PRESSURES ON SPRINKLER SYSTEMS.					Number and Per Cent. of Fires.						Average Pressure.			Average Number Sprinklers Opened.	
Pressure on Sprinklers.	Number of fires	Per cent. of fires	Average pressure	Average number sprinklers opened	Extinguished fire (or practically extinguished)		Held fire in check		Unsatisfactory		Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Extinguished fire (or practically extinguished)	Held fire in check
Less than 15 lbs.,	2	1.4	9	25.00	....	.....	1	50.0	1	50.0	....	11	7	.....	25.00
15 to 24 inclusive,	10	7.0	19	17.50	6	60.0	4	40.0	....	.....	19	20	....	11.33	26.75
25 to 49 inclusive,	48	33.6	37	9.66	26	54.2	22	45.8	....	.....	38	35	....	6.15	13.82
50 and over,	83	58.0	73	6.70	44	53.0	36	43.4	3	3.6	75	72	65	5.30	8.42
Total	143	100.0	56	8.63	76	53.1	63	44.1	4	2.8	58	55	50	6.07	11.73

EFFICIENCY OF WET OR DRY SPRINKLER SYSTEMS.					Number and Per Cent. of Fires.						Average Pressure.			Average Number Sprinklers Opened.	
Wet or Dry System.	Number of fires	Per cent. of fires	Average pressure	Average number sprinklers opened	Extinguished fire (or practically extinguished)		Held fire in check		Unsatisfactory		Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Extinguished fire (or practically extinguished)	Held fire in check
Wet system,	136	95.1	57	8.77	72	52.9	60	44.1	4	3.0	59	56	50	5.86	12.25
Dry system,	7	4.9	50	6.14	4	57.1	3	42.9	....	....	54	43	....	9.75	1.33
Total,	143	100.0	56	8.63	76	53.1	63	44.1	4	2.8	58	55	50	6.07	11.73

EFFICIENCY OF WATER SUPPLIES TO SPRINKLER SYSTEMS —As Regards Amount of Loss.

Primary Water Supply.	Number of fires	Per cent. of fires	Average pressure	Average number sprinklers opened	Number and Per Cent. of Fires.						Average Pressure.			Average Number Sprinklers Opened.		
					No claim		Small loss		Large loss		No claim	Small loss	Large loss	No claim	Small loss	Large loss
Water works,	101	70.6	60	7.40	18	17.8	78	77.2	5	5.0	60	61	53	2.56	7.91	19.50
Gravity tank,	29	20.3	32	14.93	4	13.8	22	75.9	3	10.3	21	36	16	16.25	11.77	47.00
Pressure tank,	6	4.2	86	7.16	3	50.0	3	50.0	....	....	82	91	....	4.00	10.33	.....
Automatic pump,	7	4.9	81	2.00	3	42.9	3	42.9	1	14.2	78	80	90	2.33	1.00	4.00
Total	143	100.0	56	8.63	28	19.6	106	74.1	9	6.3	59	57	45	4.64	8.60	25.14

EFFICIENCY OF WATER PRESSURES ON SPRINKLER SYSTEMS —As Regards Amount of Loss.

Pressure on Sprinklers.	Number of fires	Per cent. of fires	Average pressure	Average number sprinklers opened	Number and Per Cent. of Fires.						Average Pressure.			Average Number Sprinklers Opened.		
					No claim		Small loss		Large loss		No claim	Small loss	Large loss	No claim	Small loss	Large loss
Less than 15 lbs.,	2	1.4	9	25.00	....	....	1	50.0	1	50.0	....	11	7	.....	25.00	.....
15 to 24 inclusive,	10	7.0	19	17.50	3	30.0	5	50.0	2	20.0	18	20	20	21.33	3.40	47.00
25 to 49 inclusive,	48	33.6	37	9.66	9	18.7	38	79.2	1	2.1	40	36	35	2.44	10.39	47.00
50 and over,	83	58.0	73	6.70	16	19.3	62	74.7	5	6.0	77	73	64	2.75	7.62	8.75
Total	143	100.0	56	8.63	28	19.6	106	74.1	9	6.3	59	57	45	4.64	8.60	25.14

EFFICIENCY OF WET OR DRY SPRINKLER SYSTEMS —As Regards Amount of Loss.

Wet or Dry System.	Number of fires	Per cent. of fires	Average pressure	Average number sprinklers opened	Number and Per Cent. of Fires.						Average Pressure.			Average Number Sprinklers Opened.		
					No claim		Small loss		Large loss		No claim	Small loss	Large loss	No claim	Small loss	Large loss
Wet system,	136	95.1	57	8.77	26	19.1	101	74.3	9	6.6	60	57	45	4.92	8.62	25.14
Dry system,	7	4.9	50	6.14	2	28.6	5	71.4	....	....	45	52	....	1.00	8.20	.....
Total	143	100.0	56	8.63	28	19.6	106	74.1	9	6.3	59	57	45	4.64	8.60	25.14

Note—"Average number of sprinklers opened" does not in any case include the Unsatisfactory fires.

Office Fire in Chamber of Commerce Building, Rochester.

May 24, 1918.

Special Report by Underwriters' Bureau of the Middle and Southern States,
William A. Stoney, Manager,
(Member N. F. P. A.).

Fire was discovered by outsiders at 1 a. m. at the south end of the top floor of the eleven-story fire-resistive tenant office and mercantile building known as the Chamber of Commerce Building. Practically all the "downtown" apparatus was called into service, including eleven steamers, water tower and deluge sets. Twenty-five hose streams were used, and the Chief, Assistant Chief and two Battalion Chiefs were on duty. The fire lasted about an hour and a half.

Construction of Building.

The structure was skeleton steel frame protected by porous hollow terra-cotta tile; girders spaced 15-16 feet on centres with intermediate beams spaced 4 feet on centres; lower flanges protected by skewback tile; wall stanchions enclosed in hollow tile; beams flanged to web of girders; girders flanged to "Z" columns and stanchions. A 4-foot blind attic covered the entire room with ceiling of terra-cotta 4 inches thick, of same type and character as roof above.

Structural "Z" columns were mainly enclosed in square tile, 4-inch minimum protection; girders and beams protected by hollow porous tile, with 2-inch minimum of protection; piping inside of fire proofing. The only exception to this was in the room where the fire occurred. Here the columns were encased only in fluted oak, 16 inches in diameter, with heavy ornamental caps and bases.

Type of floor and roof arches: 8-inch flat arches, keyed segmental hollow, porous, terra-cotta tile, 4-foot span.

Wood flooring: ⅞-inch oak flooring on nailing strips embedded in a light mixture of sand and cement.

Roof covering: Slag on 4 inches of cinder concrete.

Finish of outside walls: Front walls ornamental vitrified terra-cotta. Side and rear walls brick, all backed by hollow porous terra-cotta tile.

No window protection.

No fire-resistive partitions.

Character of interior finish or decoration: Mainly close plaster walls and ceilings. The only exception to this was in the room where the fire occurred, where the walls were sheathed with an ornamental polished oak wainscoting covering the entire walls.

Stairs and elevators open.

Fig. 1. Photo of old "Chamber of Commerce" Room, Rochester, as occupied by firm of efficiency engineers prior to fire.

Spread of Fire and Damage to Contents.

The fire was confined entirely to the room in which it occurred. This room was about 52 feet by 60 feet in area, occupying the entire width of the building and two-thirds its length, and separated from the balance of the floor by an oak partition. The room was practically burned out. Nothing remained of the oak wainscoting or the oak casings of the columns. The entire contents of the room, including desks, chairs, filing cabinet cases, instruments, rugs, experimental machinery, stationery, etc., were completely destroyed.

Remarks.

The only place in the entire building where the steel columns were not protected was in the room where the fire originated. These columns, due to the intense heat, were bent, twisted and warped, allowing the roof to cave in. This pulled in the west wall and part of the south wall. The ornamental plaster ceiling was entirely destroyed, but the hollow tile protection to the roof and wall stanchions remained intact, and had the columns been protected there would have been little or no structural damage to the building. The fire did not go below the eleventh floor, but the tons of water poured into the building flooded all floors, causing heavy water damage.

The room in which the fire occurred was the former quarters of the Rochester Chamber of Commerce, and was occupied by them from the time the building was erected until last year, when they removed to their new quarters.

The old Chamber of Commerce room was designed to be of the most elaborate character possible at the time of its inception. The interior of the room was almost completely lined with carved work of an involved and costly nature. The wood itself was light fumed oak polished. At the south end was a large fireplace with a gas log, the ornamental work around same being very elaborate.

Recently this room was fitted up and refinished for and occupied by a firm of production and efficiency engineers. These people employed about 12 draughtsmen, clerks and stenographers, and had one of the finest appointed offices in the city. A considerable amount of experimental work was carried on in the design and building of machine models, and a small machine shop had been fitted up and located at the west side of the room, shut off from the main room by a 7-foot oak and glass partition. Here were located foot power lathes, saws, etc. Bench work was also done, using tin, copper and brass. A little soldering was done, and gas flames and a plumber's torch were used. It is claimed that there was no oily waste. Before the fire this part, as well as the balance of the room, was kept scrupulously clean, the scrubwomen being paid extra by the tenant for special care, as the place was an advertising asset of the company.

During the progress of the fire two distinct explosions were heard, one of which can be accounted for, as it was stated in the subsequent investigation that there was a pound can of calcium carbide in the store room. The other explosion might have been a hot air explosion. The plumber's torch was found intact the next morning, but without any gasoline.

Fig. 2. Photo taken after fire in Rochester Chamber of Commerce Building from a point a little east of that from which Fig. 1 was obtained.

Another fact brought out was that the store room in the southwest corner of the room adjoining the chimney was considered by employees to have been excessively warm and stuffy for some time. In this room were stored over a hundred pounds of granulated charcoal treated with phenol and essential oils in 1 to 10-pound packages, wrapped in paper cartons and stored on wooden shelves against the chimney. The chimney was brick, enclosed in terra-cotta tile, and appeared to be without cracks, but excessively warm after the fire. The charcoal might have ignited spontaneously.

No acids, explosives or dangerous chemicals seem to have been stored in the premises.

It is claimed by the Electrical Inspector for the inspection department having jurisdiction that the electric wiring in the building is defective and that he has been unable to get the owners to remodel the wiring. The tenant stated that when he took over the quarters some months previous to the fire they were bothered many times by short circuits, and that on several occasions when they lighted some of the clusters there was a flash. Fuses were blown frequently.

Practically all of the male employees, including the head of the firm, were inveterate cigarette smokers. The night before the fire they were at work until about 10.30 p. m. All waste receptacles at all desks were metal.

At the south end of the room there is a raised platform supported by wooden joists, with ventilating ducts below. The flooring of this platform was burned through in several places. The floor over the entire room was polished oak, and was found badly charred.

The fire evidently occurred near the west side of the room where the store room and machine shop were located, and this is the point where the roof caved in and the steel girders, beams and columns show the signs of the greatest heat. The fire swept across the room and out of the east windows.

The fire was so hot and the flames that shot out from the east windows so long that when a hose stream did reach the eleventh story the ornamental terra-cotta cornice was badly damaged, as were the ornamental facades. All window casings on all sides were entirely destroyed.

By the time the fire department reached the building the entire room was ablaze and the flames were shooting out of the east windows. On account of the height of the building and there being no standpipe or hose, it was nearly a half-hour before the department was able to get an effective stream on the fire, and by this time the entire room was a roaring furnace.

The buildings on all sides are low, and streams had to be hoisted through the elevator wells and carried up the narrow stairway. Efficient work on the part of the fire department prevented the spread of the fire to the north room, which is separated only by an oak partition and oak doors from that in which the fire occurred. The doors, however, were entirely destroyed and the partition partially burned through. After an hour and a half of strenuous work, the fire was declared under

control, but it was not until 7 a. m. that the recall sounded, six hours after the fire was discovered.

No authentic estimate has been made of the damage done, but it is variously estimated that the loss will reach $100,000 to building and contents. Nearly every tenant in the building suffered a loss by water. The loss in the room where the fire occurred is total.

The metal safes were warped, but their contents remained intact. Thirty-six hours after the fire, as one of the metal filing cabinets was being opened, the contents burst into flames. The contents of most of the cabinets, however, were burned to ashes.

Ruff Building Collapse and Fire, Sioux City.

June 29, 1918.

Special Report by C. D. Arnold, Inspector, Iowa Insurance Service Bureau,

(Member N. F. P. A.)

On June 29, 1918, at about 1.30 p. m., the four-story building situated at the northeast corner of Fourth and Douglas Streets, Sioux City, owned by the Western Iowa Company, collapsed practically without warning. Two slight explosions were heard immediately after, and the wreckage took fire within 15 minutes.

The building, which was a double front structure, was being remodeled at the time of the accident. The floor on one side, which was about twelve inches above the street, was being lowered to street level. A new front was about to be installed, as a temporary frame front had been erected ten feet back from the front of the building, plate glass removed, and jacks placed under front wall preliminary to removing supporting columns. This feature apparently had no bearing on the accident, as front twenty-five feet of building remained standing until walls were razed by fire department.

All evidence submitted to coroner's jury indicated that no fire or explosion occurred before the collapse.

Out of about sixty people in this and the two-story frame building adjoining on the east, which was crushed by falling walls, 39 lives were lost. The rescue work, which was carried on mainly by volunteers, was greatly hampered by fire and smoke, and the section where most of the victims were caught was practically inaccessible for several hours.

Construction.

The building consisted of four stories with basement; its area was 50 x 100 feet; the walls were 16-12-12-12-inch solid brick, and the foundation walls 20 and 24 inches in thickness; the first floor joists were 3 x 12-inch poplar. The building was divided lengthwise by a brick wall rising to the third floor. The fourth story was formed on two sides by a frame mansard.

Fig. 1. Photograph of Ruff Building about 10 minutes after collapse and before fire broke out. The haze is caused by dust.

Occupancy.

The Ruff Drug Store occupied the west half of the building on the first floor and basement. The east half was occupied by the Chain Grocery Company.

The second floor was occupied for dentist and doctors' offices in front, and Ruff Drug Company stock room in rear.

Fig. 2. Shows frame building east of Ruff Building in which many of the lives were lost. Photo taken about an hour after the collapse.

The third floor contained a small stock of masquerade costumes, sleeping rooms and a tailor shop.

The fourth floor was occupied entirely by the Ruff Drug Company as a stock room.

The Collapse.

The initial failure appears to have taken place in the center wall near the level of the first floor, at a point about two-thirds of the distance to the rear of the building. This wall, which was originally 20 inches thick, had been chiseled down to 16 inches or less, leaving the header courses no doubt badly shattered. Eye witnesses testify that the first rent in the west wall appeared at the center of the building, midway between the second and third floors; that the top of the wall fell in and the lower part out. The action of the east wall was not observed, but its collapse was no doubt similar to that of the west wall, the failure of the dividing wall having a tendency to draw the side walls in on the upper floors and to force them out below.

Causes.

The division wall was a 16-inch wall resting on a 20-inch brick base. When the building was originally constructed, the grade floor on both sides was about 12 inches above street level. It was testified that the floor in the east section had been lowered about ten years ago. Evidence of this could be observed after the accident on the east wall, a section of which remained standing above the first floor line. It appears that the base ledge was chiseled down to the desired height and

Fig. 3. Another photo taken at about the same time as Fig. 2.

the floor lowered on jacks. At the time of the disaster the floor in the west section was receiving similar treatment.

A carpenter employed on the work testified that the actual lowering of the floor had been completed about 48 hours before the collapse; that the joists were sawed on the west side and that the ledge was chiseled down on the east side or center wall. He asked the foreman how thick the center wall was, and the latter replied, "Twenty-four inches" (actual measurement shows that this wall was only 20 inches thick). It is therefore evident that not only was the wall 4 inches thinner than the foreman assumed, but that it had been weakened in like manner on the opposite side, possibly without his knowledge (foreman was killed). Manager of grocery store stated that to his knowledge no examination of the wall had been made from his side.

To facilitate the work of lowering the floor, it was necessary to remove stock from the basement. The best evidence would indicate that goods to the amount of four or five tons were removed from the basement and placed mainly on the second and fourth floors. Witnesses testified that three men were engaged steadily at this work for about four days. It also appears that barrel stock of considerable weight was set against the division wall on the second floor. A stock clerk in the employ of the company up to within nine days preceding the accident estimated the normal weight of stock on the upper floors as follows:—second floor one and one-half tons; third floor 900 pounds, and fourth floor between four and five tons. With the exception of about four

pounds of potassium chloride and some preparation in sealed bottles containing gasoline, he stated that no explosives were carried in stock.

Condition of Building Preceding Collapse.

All evidence submitted as to the condition of the building indicated that it had been in bad shape for some years. Two contractors who had to do with the building at the time of its erection stated that while the brick and mortar used were about on a par with material then obtainable, this was greatly inferior to what is produced at the present time. This was evident, as scarcely two bricks remained together after the collapse took place. Another contractor testified that he had made some repairs to the building about fifteen years ago, placing some tie rods through the walls on the third floor and reinforcing the foundation at the rear corner with piles, as it appeared to be settling. At this time he noticed that bricks were scaling badly and that mortar was soft.

Yet another man stated that he was asked some years ago to cut a space for a large show window in the west wall, but after examination decided that it would be unsafe to disturb the wall.

Duties of City Building Inspector.

The Sioux City building code, as passed by the City Council March 29, 1916, gives the building inspector full authority over work of this character. He is instructed to inspect all buildings upon which or in which work is being done as often as practical. It is his duty to notify all tenants that might be endangered and order the building vacated if it is deemed unsafe. The code requires that any person desiring a permit must file plans and specifications in duplicate, showing clearly how the work shall be executed and the kind and quality of materials to be used.

Procedure of Assistant Building Inspector.

E. J. O'Connor, officiating as building inspector under the title of Assistant Building Inspector, testified that he had no technical education, that he had not qualified for the position, that he made a casual inspection of the premises two days before issuing permit, that he did not go above the first floor and knew nothing regarding the weight of goods stored on upper floors, that he made no other inspection, that he considered the building safe, as he assumed the contractor knew what he was doing.

No plans were filed with the application for permit and none requested.

In conclusion, it appears from evidence submitted that the building should have been condemned twenty-five years ago, and that, considering that the city building inspector's office was the only agency which could have prevented this catastrophe, the importance of this office should be fully realized, and that it should not be entrusted to anyone who does not have the education, experience and ability to efficiently perform the duties of the office.

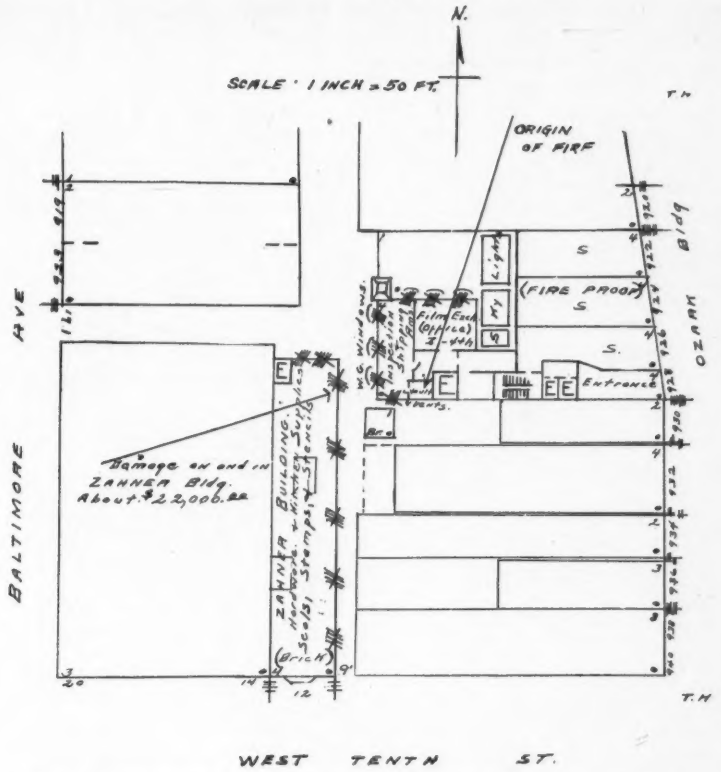


Fig. 1. Plan showing location of Ozark and Zahner Buildings, Kansas City.

Film Exchange Fire, Ozark Building, Kansas City.

July 24, 1918.

Special Report by Missouri Inspection Bureau, James A. Waterworth and Harold M. Hess, Managers,
(Member N. F. P. A.)

The Ozark Building has a frontage of about 75 feet on the west side of Main Street, about 100 feet north of West Tenth Street, and has a depth of about 115 feet extending back to about within 8 feet of the alley line. The Zahner Building has a frontage of 27 feet on West Tenth Street, and extends back to a depth of 132 feet along the west side of the 9-foot alley back of the Ozark Building; the rear 15 feet of the Zahner Building being directly exposed at right angle and at a distance of 17 feet by the Ozark Building.

The Ozark Building consists of four stories and basement, having approximate ground floor area of 8,000 square feet; it is of fire-resistive construction, with interior floorway openings in hallways protected in a standard manner and exterior openings protected by wired glass in standard metal frames; ground floor and basement occupied by retail stores, upper floors by seven film exchanges, wholesale jewelry, office equipment, etc. The Fox Film Company occupied the rear section of the third floor, about 1,500 square feet of floor space; offices in front portion being separated from inspection and shipping room in rear by a 6-inch tile partition with two openings protected by standard automatic closing fire doors; shipping room used for rewinding, inspection and shipping of films and for the storage of advertising matter, lithographs, posters, etc. Opening directly into this room was a film vault 6x7½x11 feet (500 cubic feet), using outer wall of building and rear wall of freight elevator shaft, the two interior walls being 12-inch tile plastered on each side; building floors, consisting of 6-inch tile with 2-inch concrete overlay, were used for floor and ceiling of vault; one opening protected by heavy iron vault pattern doors, not self-closing; vault vented to outer air through a 12x15-inch pipe passing through window in shipping room, outer end covered with screened hood and inner end, where opening into vault, covered with 10x12-inch iron register; one pendant incandescent lamp on heavy cord supported by outlet box attached to conduit, lamp provided with heavy outer globe which was protected by a wire cage guard; films wound on metal reels, not kept in individual containers, and piled on metal racks around sides of vault. The Kleine System Exchange occupied similar space directly overhead on the fourth floor, the offices and shipping room being separated by tile partition, with one opening protected by standard automatic closing fire door; shipping room used for the usual purposes, also for the storage of advertising matter; vault 7x10x11 feet (770 cubic feet) opened into this room, practically the same construction and arrangement as vault on floor below.

The Zahner Building consists of four stories and basement, having approximate area of 3,600 square feet, ordinary brick construction, unprotected floorway openings, non-standard skylights in roof, exterior openings facing on alley and in rear not protected, there being one tier of windows on all floors directly exposed within 17 feet by Ozark Building; occupancy, hardware and kitchen supplies, rubber stamps, seals and stencils, small sign painter's shop and photographer's workshop.

Story of the Fire.

Fire originated during the noon hour in the film vault of the Fox Film Company on the third floor, and is said to have been started as the result of an employee striking the heavy pendant lamp hung from a cord which had been spliced and taped about 1 foot above lamp. The cord parted and lamp fell to the floor; either the direct heat of this lamp or sparks caused by a short circuit of the bare ends ignited a pile of films on the floor of the vault, films not being kept in individual metal containers. The employee seized a chemical extinguisher and emptied the contents on the fire without effect; the vault rapidly filling with the fumes, smoke and flames, he was obliged to withdraw, and was

Courtesy Jno. H. Walsh.

Fig. 2. West wall of fire-resistive Ozark Building at third and fourth stories. Fire originated on third floor. Windows were wired glass in standard metal frames.

unable to close vault door behind him. It was stated that there were only about five reels of film on inspection tables in the shipping room at the time; vault and shipping room were soon entirely filled with flames, which communicated to the offices in front, one of the fire doors being propped open. The windows in the rear wall were protected with wired glass in metal frames, the chains supporting the lower sash being

equipped with fusible links. Although it was found after the fire that some of these links had fused and the windows closed, the flames immediately burst out of the rear windows, were carried upward and into open windows on the floor above, occupied by the Kleine System Exchange, in the inspection room of which a number of films, not in containers, were lying on tables. The vault door was open, and this room as well as the vault soon became entirely filled with flames, but fire did not communicate to the offices in front, the fire door having been closed by an employee. Observers claim that flames were carried upward to a height of 40 feet above the roof of the building. The intense heat melted wired glass out of sash and metal frames were badly buckled; tile coping on rear parapet walls was badly spalled and a wood door on roof house, 20 feet distant from rear parapet, badly charred. Fire in the Ozark Building was confined to the inspection and shipping room and vault of the Kleine Exchange, and inspection and shipping room, vault and offices of the Fox Exchange; also there was some smoke and water damage to hallway on third floor and to floor below.

From the various reports it appears that within a very few minutes after the fire started flames shot across the alley and entered the Zahner Building through unprotected window openings. As an indication of the intense heat, face of brick on the rear 20 feet of the east wall is badly chipped and spalled; the windows burned out, the third floor, fourth floor and roof badly charred and damaged, machinery and equipment on fourth floor badly damaged by direct fire. There was also considerable smoke and water damage to floors below. The exposure fire was confined to Zahner Building, except for slight damage to window frames in rear of building at 919-23 Baltimore Avenue. There was no loss of life or personal injury.

Fire was fought and extinguished by public department, first alarm coming in over telephone at 12.32 p. m., the usual equipment responding to downtown alarms reporting promptly; nine engine and hose streams were used, and fire was under control in less than one hour.

Damage to Ozark Building was about $3,000.00.

The contents of vaults and shipping rooms were practically totally destroyed; value of furniture and fixtures and advertising matter stated to be anywhere from $500.00 to $1,500.00; the loss on films is questionable, the value of films depending upon length of service and popularity of same from a rental standpoint. The damage to other contents of Ozark Building was caused principally by smoke and water and is nominal. Damage to Zahner Building about $5,000.00, to contents of Zahner Hardware Company about $10,000.00, to contents of Partridge-Scotford Stamp Company about $7,500.00, and to other contents nominal.

Conclusions.

This fire is a repetition of the type of film fire that has occurred in many other properties of this class, and again brings to the attention the ever-present danger to life and property caused by the extreme hazard of films where not properly handled or stored. It also emphasizes the fact that a building of fire-resistive construction with exterior openings protected with wired glass in standard and automatic closing metal frames does not always confine a fire originating therein, and that

Courtesy Jno. H. Walsh.

Fig. 3. East wall of Zahner Building exposed at right angle and at a distance of 17 feet by Ozark Building. Damage on and in this building about $22,000.

a relatively small fire of short duration can extensively damage surrounding property.

The question of protecting nitro-cellulose film and surrounding property has been engaging the thought and attention of experts in the motion picture industry as well as in the fire insurance business for the past few years, and at the present time is unsettled, there being conflicting opinions concerning the various hazards and best methods of

safeguarding same. However, the following conclusions seem warranted:

That until such time as sure methods of safeguarding this extreme hazard are developed and made practical, films should not be stored in the so-called downtown fireproof office building, nor in any other high or multiple occupancy building in the congested districts.

That all films, except when in actual use or in process of re-winding, inspection or repair, should be kept in individual containers of an approved type and of fire-resistive and non-heat-conducting material, and should be stored in vaults of approved construction and design, having automatic closing fire doors maintained in operative condition at all times; lights in vaults, if any, to be only by electricity in fixed devices attached to ceiling or supported on approved pipe hangers.

That rigid rules should be enforced against smoking, carrying matches, and the carelessness that seems to be common in establishments of this character.

Green River Distillery Fire, Owensboro, Ky.

August 24, 1918.

Special Report by Kentucky Actuarial Bureau, G. H. Parker, Manager,
(Member N. F. P. A.)

The Green River distillery was of medium size, having a mash capacity of about 750 bushels yielding 74 barrels of whiskey per day. The original plant was erected about 1887 by J. W. McCulloch, who operated same individually until July, 1903, when the present company was formed. The plant consisted of distillery, free warehouse, four bonded warehouses, bottling house, cattle sheds and office, of frame, brick and metal on open studding construction. It had no outside exposures, but mutual exposures were severe. General care and cleanliness were fair for this class of property under good management. There was no public protection, the plant being located approximately half-a-mile beyond the corporate limits of Owensboro, Ky. Private protection from unapproved chemical extinguishers, water barrels and buckets was inadequate. A watchman reported at nights on portable clock, with 12 stations arranged on outside of buildings.

Distillery ceased operation in June, 1915, and since had operated only its bottling department.

Construction.

Still house, cattle sheds and corn crib, all frame open and part ceiled finished construction covered with composition and metal roofs.

Free warehouse, adjacent bonded warehouse 9A on west. Height: one story. Area: 3,960 square feet. Walls: 12-inch brick, plain finish. Roof: metal on single boards and joists. Ceilings: open joist. Floor openings: none.

Bottling House: Detached 8 feet south of free warehouse and west of bonded warehouse 9A. Height: one story, with four-story whiskey tank tower. Area: 3,440 square feet. Walls: 12-inch brick, plain finish. Roof: metal on single boards and joists. Ceilings: metal. Floor openings; unenclosed stair and elevator from first to fourth floor of tank tower.

Bonded Warehouses: No. 9A—Height: one story (17 feet). Area, 24,534 square feet. Capacity: 16,575 barrels. Warehouse 9C. Height: five stories (45 feet). Area: 18,800 square feet. Capacity: 24,400 barrels. Warehouse 9B—Height: one story (22 feet). Area: 21,850 square feet. Capacity: 14,450 barrels. All of these warehouses were metal on open wood studding construction, with wood floors and metal and composition roofs. Patent racking open from floor to roof.

Bonded Warehouse No. 9: Height: 3 stories (40 feet). Area: 20,930 square feet. Walls: brick 16-inch, plain finish; 24 x 20-inch pilasters spaced 15 feet on centers; parapets 24 to 36 inches. Roof: approved composition on single boards and joists. Patent racking open from first floor to roof. Capacity: 14,500 barrels. A brick gauge porch extended the entire width of warehouses 9 and 9C on north, each warehouse communicating therewith through one opening in fire wall on first floor, protected by standard tin-clad automatic fire doors. Open elevator in gauge porch from first to fourth floor.

Story of Fire.

The fire was discovered about 6:45 on Saturday evening by the night watchman, who was eating his supper in the plant office. He stated that the fire was in a box car loaded with whiskey in cases on the railroad siding adjacent to bonded bottling house, although it is generally reported that the fire was discovered in a pile of rubbish between the box car and bottling house. The watchman made a futile effort to extinguish the flames with chemical extinguishers, and then transmitted the alarm to the fire department by telephone. The alarm was answered by the combination hose and chemical engine (motor-driven), but upon its arrival the fire had gained such headway in bottling house and free warehouse that its effort was of no avail, since no public hydrants were within reach, and only the chemical engine could be utilized. The wind at the time was from south to north, and soon the distillery building was in flames. The wind changed suddenly and the flames began blowing towards the whiskey warehouses from the distillery. Iron-clad bonded warehouse 9A was soon on fire its entire length, and radiated its heat over the roof of brick warehouse No. 9, adjacent to iron-clad warehouse 9C, which started burning at the roof eaves at the northwest corner of the building. Very shortly the brick warehouse No. 9, located between 9A and 9C, had ignited on the roof, and all three warehouses were in flames. The radiated heat from these shortly caused the roof of warehouse 9B, 88 feet distant, to burst into flames from end to end. The U. S. Revenue Agent, who was on the ground, would not allow the warehouses to be opened until practically all were on fire, when he gave his permission to open the rear door of warehouse 9C, from which about 50 barrels of whiskey were removed. The fire burned fiercely until every building of the plant was totally

destroyed. The burning whiskey flow or flying brands were no factors whatever in causing the fire to communicate from building to building. Every building was ignited near the roof from the radiated heat, which was intense.

Loss.

The buildings and machinery of the plant were insured for $125,350, which appears to be considerably in excess of the value at time of fire, since, due to the pending prohibition legislation in Congress, distillery plants generally are worth little more than their wreckage value. All buildings outside of distillery proper were in fair repair, but probably could never be utilized for any other purpose. The distillery building was very old and in poor repair and probably would never have been operated again. An effort was made to obtain the number of barrels of whiskey in storage from the Collector of Internal Revenue, but he advised that the information would only be available upon order from the Commissioner of Internal Revenue at Washington, D. C. The books of the distillery indicate that approximately 41,050 barrels of whiskey were in storage at time of fire. The market value of whiskey on the day of the fire ranged around $1.35 per gallon before the Government tax was added, which would indicate a loss on whiskey of something over $2,000,000 without the Government tax.

Various "customers'" whiskey was in storage in the warehouse, these owners being widely scattered over the country.

Shortly after the Government's order closing distilleries for the duration of war, the price of whiskey increased until it reached $3.10 per gallon. During the last two months, pending the outcome of prohibition legislation in Congress, the price has declined to around $1.35 per gallon.

During the rising market many speculators invested heavily in the product, some paying nearly the top price of $3.00 per gallon, thinking that the advance would reach several dollars more per gallon. Insurance in most instances was effected at the purchase price, and in some cases this amount of insurance was not reduced to meet the declining market value; hence, probably a considerable amount of "customers'" whiskey was over-insured at time of the fire.

Conclusions.

The result of this fire suggests that more consideration should be given to providing up-to-date private fire protection at distillery plants, many of which are beyond radius of public protection. No doubt had this plant been equipped with outside hydrants properly equipped and housed this fire could have been extinguished before any headway was gained. Since the Government is always the heaviest loser in bonded warehouse fires—in this instance the tax loss amounting to above $6,000,000—it would seem to be within Governmental province to require up-to-date fire-fighting facilities at distillery plants.

Unsatisfactory or Serious Fires in Buildings Equipped with Sprinklers.

When sprinklers fail the causes are almost invariably clear. The fires below are selected to indicate such causes that they may be generally understood and satisfactorily met.

S-20596. Wooden Box Factory. Fire in shavings is thought to have been caused by heat from boiler passing through cracks or spaces between the bricks of a 12-inch wall separating the boiler from the shavings vault. After several attempts on the part of employees to extinguish the fire in the shavings with chemical extinguishers, the fire department was summoned and one public hose stream was used. The loss was confined to several broken panes in the skylight over the vault, but the plant had to be temporarily shut down owing to the presence of water in the boiler room. There were two sprinklers on a dry pipe system in the vault, and both of them fused during the fire, but no water was discharged. Examination after the fire showed that the small pipe supplying the two heads was frozen at a point outside the brick wall of the vault, the heat from the fire being insufficient to melt the ice and release the air.

Summary: Freezing.

S-20625. Paper Mill. Cinders from the boiler fires were piled against the outside of a building to the level of the sills of the lowest row of windows. It is believed that burning cinders ignited a wooden window frame and sash, and fire was thus communicated to the interior of the building. Fire started at basement of 3-story finishing and paper storage building which communicated by a brick passage, 35 feet in length and protected by a fire door at each end, with a 1-story machine room to the south. On the east the finishing and storage building communicated with unprotected wooden passages leading into and over the roof of the boiler house. The boiler house was cut off on the south from the adjoining machine room and on the east from the wet machine building on the first floor only. Unprotected windows in the second story of the wet machine building looked over the boiler house roof and into the screen room above the boiler house. The eastern wall of the wet machine building was a fire wall, with fire doors and wired-glass windows facing the digestor and acid buildings.

The fire doors were tin-clad 3-ply automatic sliding doors, with tracks bolted through walls, but were not standard. In a number of instances these doors were in the direct path of the flames, which they withstood fairly well, except in one case, where the automatic attachment did not work (on second floor of wet machine building), and in another case where the supporting wall fell in. Where the exposure was very severe, interior gases forced the tin loose near the centers of

the doors on the side next to the fire, but the tin on the farther side held well.

A considerable wind from the west carried the fire from the basement of the finishing and storage building through the unprotected passages into the boiler house. The roof of this was supported by bare steel trusses, one of which also carried a roof structure over the side of the boiler house next to the wet machine building. This structure contained screens for wet machines, and when the truss warped and fell, carrying with it the roof structure and screens, a clear path was opened to the second story of the wet machine building.

The finishing and storage building was practically destroyed, as were the passages between this building and the boiler house. The roofs were burned off the boiler house and wet machine building, the second floor of the latter being also considerably damaged.

The arrival of the fire department was delayed by a mistake of the watchman, who turned in an alarm from the wrong box, necessitating a detour on the part of the department when they arrived on the opposite bank of the river beside which the plant was erected.

The entire building in which the fire originated and the second and part of the first floors of the wet machine building were equipped with automatic sprinklers on a dry system, although some of the heads in the latter were very badly corroded. All the sprinklers opened, but apparently no water was discharged. The condition of the heads and pipes also indicated lack of water, both being much more affected by the heat than would normally have been the case. As far as could be learned, the dry valve operated satisfactorily, and the cause of the failure was doubtless a frozen supply main, the "freeze-up" probably occurring where the pipe crossed a bridge in a box filled with horse manure. **The secondary supply, an old 900-gallon rotary fire pump, was out of service at the time of the fire, due to lack of power, the water wheel alone not being able to start the pump and steam for the engine not being maintained at night or on Sundays.** The fire occurred on a Sunday.

Summary: Freezing.

S-20639. Warehouse. The one-story shipping shed in which fire originated was open joist construction with tin-clad roof. It adjoined a two-story and basement brick warehouse of plank and timber construction, communicating freely with the warehouse through unprotected windows along the latter's north side. Other openings had wooden doors, the only exception being a fire door at the elevator well. Unprotected windows on the second floor of the warehouse faced over the shed. At about 11.20 p. m. the inside watchman smelled smoke, and almost immediately afterwards discovered the fire, turning in an alarm forthwith. By the time the fire department arrived the shed was all ablaze inside, the flames had broken the glass windows in the warehouse, and the sprinklers were keeping the fire from entering.

The tin-clad roof of the shed kept the fire from the windows of the second story, and the fire door at the elevator well protected the warehouse at this point. Sufficient heat, however, entered the well to open a sprinkler at the top, and sprinklers in the stairway also operated.

There were 40 sprinklers in the shipping shed, but these were shut off during the cold weather, and in the excitement no one thought to open the controlling valve. The management had been urged on several occasions to place the sprinklers in the shed on a dry pipe system, instead of shutting them off in the winter, but the reply had been that the values in the shed were not large, and those in charge knew that the sprinklers were shut off and could easily open the valve. As it happened, not only was the valve not opened when the fire occurred, but the values stored in the shed were unusually heavy, owing to delays in shipment caused by the car shortage.

The loss in the frame shed was large and there was also considerable water damage in the warehouse, where about 30 sprinklers operated for two hours in the first story, drenching a large stock of finished copper and nickel-plated ware packed in crates on the floor and a quantity of tin and galvanized ironware, together with a carload of shooks, kegs of nails, etc., in the basement. The main floor of the warehouse was 3-inch plank, and this held the water to a depth of several inches, allowing it to drip through onto the open stock in the basement. The floor drains in the basement being closed and no one knowing where they were, a great deal of water was allowed to collect before means were found to drain it off.

S-20651. Cotton Mill. Foreign material struck fire in card and blaze was apparently extinguished by 32 sprinklers. The overseer directed the master mechanic to close the main outside valve, and himself shut the valve which controlled the sprinklers in the card room and the attic above. Shortly afterwards the fire broke out again, and the outside valve was opened, but owing to the closing of the inside valve no water reached the sprinklers. An attempt to reach the valve in the card room was unsuccessful because of the location of the valve and the dense smoke given off by the burning cotton. Fire communicated through chutes to floor above, and a heavy loss resulted.

Summary: Valve closed.

S-20670. Spool and Bobbin Factory. Fire started in bobbin dryers, of which there were four, two in the second story and two in the third story in the north-east corner of the main building. These were old-style dry rooms in poor repair, being built of boards with hollow walls. The heat had shrunk some of the boards so that there were cracks between them. The room adjoining the upper tier of driers was about 40 feet square and was used for storage. At the time of the fire sprinklers in this room were out of service, as a fourth story was being added to this section, and the old roof had to be lowered to form a floor. The point of origin of fire was in the lower dry room, whence the flames communicated through a hollow partition to the dryer above, and from there obtained access through cracks to the storage room already mentioned. Similar cracks permitted the fire to spread on the floor below. Attempts were made to extinguish the fire in the dryers and hollow wall with chemical extinguishers, and in the excitement, when this method failed, the dryer doors were evidently left open, helping to communicate the flames to the rest of the plant. The fire made very

rapid headway in the storage room, the contents of which were very congested and combustible.

From the fact that those who used chemical extinguishers in the dryer only saw smoke therein, it may be assumed that when the sprinklers in the dryer operated they held the fire there, but owing to the fact that they were high test heads on a dry system, the delay in operation had permitted the flames to get into the hollow wall and thence into the upper dryer and storage room. The system was supplied from a dead end main which was subsequently found to be considerably obstructed by dirt and corrosion. About five minutes after the fire was discovered a private hose stream was in use, and fire department streams were laid within 10 minutes. Probably the main was not capable of delivering more than one good stream, and consequently the sprinklers were robbed of most of their water. The plant, which was practically destroyed, was not accessible from the rear, being located on a bank sloping to a river and having its top floor nearly on a level with the street.

S-20820. Woolen Mill. Defective electric wiring was responsible for this fire, which occurred in a carding room located on the top floor of a 3-story building. An attempt to check the flames with water pails and chemical extinguishers proved ineffective. Numerous sprinkler heads on an "old standard" system operated and discharged water under good pressure, but the fire gained such rapid headway that it was soon evident that the sprinklers would be unable to control it. The room contained 19 sets of carding machines and about 10,000 lbs. of mixed stock, the floor was badly saturated with oil, and there were large accumulations of highly inflammable dust at the ceiling. About two hours after the start of the fire, falling walls, floors and machinery, etc., in the carding and spinning building broke the 4-inch and 5-inch sprinkler risers, rendering the fire pump and the remainder of the sprinkler system useless, as the close proximity of the post indicator valves to the burning building made it impossible to shut off the water from these connections. In the absence of standard cut-offs, the fire spread to other buildings in the plant, the three principal buildings of the main group being totally destroyed, with a loss of about $500,000.

Summary: Severe hazard and poor location of post indicator valves.

S-20910. Paper Mill. This mill had been shut down for a number of years, and its operation was resumed only a few months before the fire. When the plant was restarted the sprinkler system was out of commission owing to burst pipe and inoperative pumps. The restoration of the fire protective equipment was deferred until all other repairs had been completed, and although at the time of the fire the sprinkler pipes had been put in service and the pumps overhauled, the dry valve was still unrepaired, and as parts for the automatic regulator on the fire pump could not be obtained, water was kept shut off the system. Consequently when fire occurred there was considerable delay before the sprinklers were put into operation. The location of the fire was in the paper raw stock storage room, where large bales of very inflammable material were piled in dense formation. The buildings were

frame construction, long, and without fire stops, and a terrific wind was blowing at the time of the fire. For the reasons stated above, a large number of sprinklers opened before any water was available, and although two pumps were put in operation the pressure was probably very low.

The fire swept through the entire mill and had been burning only a comparatively short time when the timbers supporting part of the gears of the rotary pump fell and put this pump out of service. The steam pump continued to run until the roof of the boiler house fell and broke the steam main. The fireman operating the steam pump did not leave the boiler house until the roof was in a dangerous condition. Just before leaving, he shut the valve controlling the sprinklers, thus throwing all the water into the hydrants.

The loss was total.

Summary: Water shut off.

S-21710. Woolen Mill. Four sets of cards were being operated all night in the fourth story of a five-story brick mill, and work was also in progress on the third and fifth stories. Fire occurred in the card room about 3.15 a. m. The gravity tank of the local waterworks system (204,000 gallons capacity) was nearly full at the time and one of the pumps was running. The engineer at the waterworks station, however, was a new man, and when he received the alarm at 3.20 a. m., he closed the valve (all but a few turns) in the line discharging to the town, instead of opening it. The supply reaching the mill from this source was consequently very much reduced. When the waterworks superintendent reached the station at about 3.30 a. m. and discovered what had been done, he opened the valve and started both pumps on the system, but did not shut off the standpipe so as to get direct pump pressure until 3.50 a. m. The demand for water was so great that the waterworks pumps could not keep up the pressure. When the roof of the mill fell in at 6 a. m., the post indicator valve controlling the sprinklers was closed, and the pressure in the town mains then rose to about 110 lbs. At this point an 8-inch main burst and the town system had to be shut down.

Coincident with the mistakes in the manipulation of the waterworks apparatus was the poor action (and consequent shutting down) of the steam fire pump at the mill. The result was that there was little or no pressure from any source available on the sprinkler system or for hose streams. The fire spread practically unchecked from the fourth to the fifth floor, passing either through cracks between the floor and wall or outside from window to window.

A steam fire engine was held in reserve in the town, and the Fire Chief sent for this when he found no pressure available for hose streams. About 40 minutes after the start of the fire this engine was brought into action, taking suction from a nearby canal, but after running awhile the packing of the water ends of the machine blew out, and it also had to be shut down. Eventually the fire was brought under control by steam pumping engines sent from neighboring towns.

While all stories of the mill were completely drenched, the floors seemed to hold water fairly well, and it is rather remarkable that the

floor of the card room itself was not burned. The two upper stories were, however, completely gutted.

Even with the failure of both primary and secondary water supplies it was a point of interest why the first few sprinklers that opened did not control the fire, as it seemed that they must have been sufficiently supplied at the start. Some of the sprinkler piping was taken down and it was found that the tee on the branch line supplying the three heads directly over the point of origin of the fire was completely obstructed by a chip and by pipe scale. Undoubtedly, therefore, the first three sprinklers did not receive a proper water supply. A piece of a pump valve was also found obstructing a 2½-inch pipe in the system. The fire probably flashed quickly over the mixed stock that was being worked on open cards and the heat generated must speedily have opened a good many sprinklers. The loss was about $225,000.

S-21820. Cotton Waste Mill. A three-story brick and timber building was occupied as a cotton waste mill. Fire originated on third floor and was discovered by an outside watchman. One hundred and one sprinklers opened on a dry system and held the fire in check. Owing, however, to the "flashy" character of the stock, the blaze probably spread rapidly while the dry valve was operating. The firemen stated that when they entered the building with hose streams the sprinklers were only dribbling water, and there was evidently not sufficient water for both hose streams and sprinklers. Fire was confined to the third floor, but the loss exceeded $50,000.

S-21843. Rubber Mill. Small fires had been frequent in the vicinity of the heaters at this plant. At 3 a. m. on the day of the fire the steam-fitter entered the factory to test recently installed heating equipment; at about 5 a. m. he smelled hot rubber and on investigation discovered that a sprinkler head had opened in the heating room on the first floor. He immediately closed the main gate valve which controlled this section and replaced the fused head. He then opened the gate valve, at the same time shutting off the alarm cock on the system so that the alarm should not continue to ring as it usually did in such cases. He went about the factory doing his work and later smelled hot rubber again. He endeavored to find the trouble but was unable to discover any cause for his suspicions. However, at about 5.50 a. m. he discovered that another sprinkler had opened in the vicinity of the first, and he again shut the controlling valve, proceeding to the boiler room to get a new head. On his return the whole room was full of smoke and flames which, of course, prevented him from reopening the valve. The fire had already gained such headway that it was impossible to approach it and the three or four employees in the building were warned to leave quickly. An alarm was turned in but when the fire department arrived, at 6.20 a. m. it was evident that the factory could not be saved, the tremendous heat keeping the firemen at a distance. All that could be done was to save nearby dwellings, some of which were severely scorched. This task would have been much more difficult if the wind had not been blowing away from the structures most dangerously exposed.

Summary: Water shut off.

S-21903. Car Works. Fire started in heater room located near the center of and outside the south wall of a frame building, having an area of 76,320 square feet, used for painting, stencilling, storage and shipping of freight cars. As the result of a "freeze-up" the heater room and adjoining portion of the car shop were temporarily deprived of sprinkler protection. Repairs were in progress on the day of the fire which was discovered at about 11.55 a. m. The entire centre part of the building was soon ablaze, collapsing at about 12.20 p. m., and carrying with it sprinkler pipes, mains and risers. Other sprinklers did good work at the western end of the building, where the fire was checked. Many newly painted freight cars, however, were destroyed together with a large section of the building.

Summary: Water shut off after "freeze-up."

S-22074. Pier Shed. The building in which fire occurred was a one-story pier shed 550 feet long and 60 feet wide. The walls were frame, corrugated iron on wood frame, and, as to part of the north wall, brick. The roof was 1-inch boards on joists on wood trusses covered with slag and composition. The contents of the shed comprised nearly 7,000 bales of wood pulp, a few bales of oakum and a small quantity of lumber. Rather more than half the building was without sprinkler protection, but the fire started in the sprinklered portion. The cause was a gasoline blow torch which ignited baled oakum when the employee who was about to use it to thaw out a frozen water pipe slipped and fell. An alarm was immediately turned in and fifteen public hose streams were used, but by the time the blaze was extinguished the shed was almost a total wreck.

As to the failure of the sprinklers to control the fire, investigation showed that some weeks earlier the dry pipe valve had tripped as the result of injury to a sprinkler head caused by a workman making slight changes in the building. The system was shut off and drained after it had filled with water. During the period between this accident and the fire the temperature in the shed did not rise above freezing point. No serious difficulty was experienced in maintaining air pressure, which would indicate that insufficient ice formed in the pipes to damage the system, but unquestionably the pipes did contain ice when the fire occurred. The evidence showed that all the gate valves were open and that the sprinklers operated, but that very little water was distributed. As the city pressure was not unusually low at the time, the poor distribution was probably due to obstruction of the pipes and orifices by ice.

There is, however, another theory as to the cause of the failure. A large door at the northwest corner of the building, near where the fire started, was open, as were also doors farther down the shed. There was a high wind from the northwest and it is suggested that the draft was so great that the heat was carried away from the sprinklers as fast as it was generated and that the heads were not affected until the fire had gained considerable headway, with the result that so large a number of sprinklers operated as to reduce the water pressure below the effective limit.

S-22078. Button Factory. Fire occurred from an unknown cause on the second floor of a three-story and basement semi-mill building. About 400 sprinklers on a wet system opened, but without effect, the loss being nearly total. The system was equipped with a 27,000-gallon gravity tank and investigation after the fire indicated that water at the top of the tank riser and at the bottom of the tank was frozen sufficiently to prevent any water leaving the tank.

Summary: Freezing.